Chapter III.—SYNOPSIS OF ZOOLOGICAL DATA.

1. THE DREDGING RECORDS.

Complete records were kept of every dredge haul of the Survey, comprising such data as the bearings, date, depth, etc., at each station, as well as a list of the aggregate fauna and flora found to occur there. It was our original expectation to publish the entire set of station records as an appendix to the present report, for it would certainly be desirable to insure the permanency of these records through printing. They are the crude data upon which most of our ensuing discussion is based, and it is highly probable that they would yield other results of value if subjected to further analysis. Here, and here only, do we find what forms of life are associated together upon a given area of the sea bottom. Owing to the voluminous character of these records, however, it has not been found practicable to publish them in their entirety, although a "List of Stations" is presented at the close of section I. As regards the associations of species, we must be content at present with presenting the data in a generalized form, except for the reproduction of a very few complete station records by way of illustration.

In all there are 458 stations, belonging to the regular series, which may be classified as follows:

Fish Hawk, Vineyard Sound	218
Fish Hawk, Buzzards Bay	66
Fish Hawk, Crab Ledge	7
Phalarope and Blue Wing, Vineyard Sound	77
Phalarope, Buzzards Bay	90
Total	458

With a few exceptions (see below) these stations were all dredged during the summers of 1903, 1904, and 1905. The *Fish Hawk* was employed during all three of these seasons, the *Phalarope* (supplemented by the *Blue Wing*) during the second and third seasons. Owing, however, to an accident which prevented the use of the *Phalarope* along the western shore of Buzzards Bay in 1905, the latter region was not dredged until the summer of 1907. These 1907 stations have been charted along with the others and the records included in the same series. There are likewise included with the regular series certain repeated stations. Owing to the somewhat tentative character of the Vineyard Sound dredgings in 1903, 34 of these earlier stations were redredged (approximately) in 1904, partly with the *Fish Hawk*, partly with the *Phalarope*. Such stations have been designated by the original number, with the addition of the Latin word "bis." The "bis" stations have all been treated as *Fish Hawk* stations, and a list of them is published at the end of the *Fish Hawk* series. The records for the occurrence of each species at this group of repeated stations have been incorporated serially

with the others in the annotated list, and these records have been included in plotting the distribution charts.

During the summers of 1906, 1907, 1908, and 1909 various supplementary dredgings were carried on with both the *Fish Hawk* and the *Phalarope*, and at least 150 stations were dredged. These were in most cases more or less approximate repetitions of stations of the regular series. On most of these occasions search was made only for particular species, and no list was kept of the entire collection of organisms brought up. In the case of the hydroids, Bryozoa, and Foraminifera, however, and of unusual species belonging to any group, the records derived from these supplementary stations are to a large extent included with the others, the year of the dredging being indicated. During the summer of 1909, 26 of the earlier stations in Buzzards Bay (mainly of the *Fish Hawk* series) were repeated with rough approximation by the *Phalarope*, and fairly full lists were made of the organisms taken at each.[a] These lists have been appended to the regular series. Several trips were likewise made during the summer of 1907 for the special purpose of collecting algæ.

To what degree the earlier records have been confirmed or corrected by these supplementary dredgings will appear from time to time in the special discussion relating to particular species. It may be noted in passing, however, that the later operations have added very materially to the accuracy of our results as a whole.

A chart (no. 226) has been prepared indicating the position and, so far as possible, the direction and extent (see p. 18) of the dredgings of the survey. Upon this chart the stations are numbered, these numbers corresponding to those given in the lists. The numbers employed are arranged consecutively according to date. They do not therefore bear any necessary relation to the position of the stations. In order to facilitate the finding of a given station by the reader the following general statements are offered:

(1) The *Fish Hawk* stations are all indicated by numbers of four digits, commencing with 7, thus: 7521, etc. The *Phalarope* and *Blue Wing* stations are indicated by numbers ranging from 1 to 167.

(2) *Fish Hawk* stations are designated either by a circle or by a chain of two, three, or four smaller circles, connected by a straight or curved line (see p. 18). *Phalarope* and *Blue Wing* stations are designated by arrows, which show the direction of the haul, and, very roughly, its relative duration. These last are in all cases near shore, except for a few upon the Middle Ground shoal at the eastern end of Vineyard Sound.

(3) *Fish Hawk* stations 7521 to 7602 are in Vineyard Sound, commencing near Nobska Point and running to the westward. They are arranged at intervals of about three-fourths of a mile along lines crossing the Sound at a distance of about 1 mile from one another. Near the western end of Vineyard Sound three of these lines are numbered in a reversed order, i. e., stations 7581 to 7587 are along the line connecting Gay Head and Cuttyhunk, the next stations in serial order, being upon a line passing from Nashawena to a point about 1 mile east of Gay Head.

(4) Stations 7603 to 7609, inclusive, are at Crab Ledge (see chart 223), and are therefore not included upon the present chart.

(5) Stations 7610 to 7675 are in Buzzards Bay—7610 to 7635 are in the upper half, starting from a point near Woods Hole; 7636 to 7675 are in the lower half.

[a] Certain groups, however, did not receive adequate attention, and comparatively few of these specimens were referred to specialists for identification.

(6) Stations 7676 to 7783 (except 7711 to 7716) are in Vineyard Sound, beginning at the western end and passing eastward, though the order is not at all regular.

(7) Stations 7711 to 7716, inclusive, do not appear upon the chart.

(8) Stations 1 to 19, 24 to 43, and 52 to 167 were dredged by the *Phalarope;* 20 to 23 and 44 to 51 by the *Blue Wing.*

(9) Stations 1 to 77 are in Vineyard Sound. No. 1 is along the shore of Nonamesset Island. The first series continues, not always in regular order, to 38, at Cuttyhunk, though 35, 36, and 37 are at Sow and Pigs Reef. Stations 39 to 43 are along the shoal Middle Ground. Stations 44 to 51 and 56 to 60 are at Gay Head; 61, 62, and 63 are near West Chop; 64 to 68 are along the shore of Marthas Vineyard from Prospect Hill to Cedar Tree Neck; 69 to 72 are in Vineyard Haven; while stations 73 to 77 extend from Nortons Point to Cedar Tree Neck.

(10) Stations 78 to 167 are in Buzzards Bay. They commence at Nashawena Island, and extend northeastward along the shores of Pasque and Naushon; the series then skips to Cuttyhunk (99 to 104), then to Weepecket Islands (105 to 110), then to Cuttyhunk again (111 and 112) and to Penikese (113 to 116). Station 117 is at Uncatena Island, and 118 to 123 are in the immediate neighborhood of Woods Hole. From this point the series extends pretty regularly up the eastern shore of Buzzards Bay, and from the head of the Bay, down the western shore, at wider intervals.

The complete records of four of our stations (dredge hauls) are presented herewith. We have selected one *Fish Hawk* station in Buzzards Bay (7656), one *Fish Hawk* station in Vineyard Sound (7730), one *Phalarope* station in Vineyard Sound (52), and one *Phalarope* station in Buzzards Bay (83). In each case, that station, within each group, has been selected from which the greatest number of species was recorded. Thus, 61 species of animals and 20 species of plants were found at station no. 7656; 81 animals and 13 plants at no. 7730; 72 animals and 14 plants at no. 52; and 68 animals and 11 plants at no. 83. These are accordingly not typical dredge hauls in the sense of being average ones, numerically speaking.[a] On the other hand, the bottoms which were traversed were probably characteristic enough of the regions which they represent.

No attempt has been made by us, here or elsewhere, to count the number of *individual organisms* taken in a single haul of the dredge. Such figures are, however, so entirely dependent upon the character and size of the dredge employed, and the duration of the haul, that we do not believe that the value of any results of this sort would have been commensurate with the labor involved in counting.

Even these maximum figures from our dredging in Vineyard Sound and Buzzards Bay fall much below some of those offered by Herdman and Dawson (1902, p. 20 et seq.). For example, in three successive hauls in the neighborhood of Port Erin, at depths of 16 to 18 fathoms, these writers record 93, 111, and 156 species of animals. Moreover, we are informed that these hauls are "characteristic" and not "picked" ones, being made "for the purpose of comparison with some published from other seas." Further comparisons between the fauna of our region and that of the Irish Sea, in respect to wealth of species, will be found on pages 88 and 89.

[a] The numbers for these stations are about twice the average ones. See p. 77.

FISH HAWK STATION 7656.

August 12, 1904.—North end Penikese Island W. by S., 3½ miles; Dumpling Rock Light NNW. ¾ W., 4⅞ miles; 8 fathoms; sandy mud; 7-foot beam trawl, scrape dredge; drift NE. ⅛ mile.

ANIMALS.

HYDROZOA:
- ?Obelia geniculata (on Laminaria).
- Tubularia crocea (few colonies).

BRYOZOA:
- Ætea anguina.
- Bugula turrita.
- Cellepora americana.
- Lepralia sp. (americana or pallasiana).
- Membranipora pilosa.
- Schizoporella unicornis.

ANNULATA:
- Arabella opalina (1).
- Brada setosa (1).
- Cistenides gouldii (1 tube).
- Clymenella torquata (several tubes).
- Diopatra cuprea (few tubes).
- Harmothoë imbricata (1 tube).
- Lumbrineris hebes (1).
- Nephthys incisa (several).
- Nicolea simplex (2 tubes on Laminaria).
- Ninoë nigripes (several).
- Rhynchobolus americanus (1).
- Spiochætopterus oculatus.
- Spirorbis spirorbis (on Laminaria, etc.).
- Trophonia affinis (several).

CIRRIPEDIA:
- Balanus sp. (probably eburneus) (few).

DECAPODA:
- Cancer irroratus (several).
- Libinia emarginata (several large and small).
- Neopanope texana sayi (1).
- Pagurus longicarpus (several in shells of Nassa).

AMPHIPODA:
- Æginella longicornis (1).
- Amphithoë rubricata (1).
- Caprella geometrica (1).
- Ptilocheirus pinguis (many).

ISOPODA:
- Erichsonella filiformis (1).

PELECYPODA:
- Anomia simplex.
- Arca transversa (few shells).
- Astarte castanea (several shells).
- Astarte undata (several shells).
- Callocardia morrhuana (few shells).
- Cardium pinnulatum (few shells).
- Clidiophora gouldiana (few).
- Ensis directus (few shells).
- Mytilus edulis (several large and small shells).

PELECYPODA—Continued.
- Nucula proxima.
- Petricola pholadiformis.
- Tellina tenera.
- Venus mercenaria (few small shells).
- Yoldia limatula (1).

GASTROPODA:
- Anachis avara (few shells).
- Astyris lunata.
- Crepidula fornicata (few shells and living).
- Crepidula plana (few shells).
- Littorina litorea (1 shell).
- Tritia trivittata (several shells).
- Turbonilla vinæ.
- Turbonilla winkleyi.
- Turbonilla sp.

CEPHALOPODA:
- Loligo pealii (eggs and young).

PISCES:
- Paralichthys oblongus (1).
- Prionotus carolinus.
- Pseudopleuronectes americanus (3).
- Spheroides maculatus (1).
- Stenotomus chrysops (many young).
- Urophycis tenuis (1 living).

PLANTS.

PHÆOPHYCEÆ:
- Chorda filum (1).
- Chordaria flagelliformis (many).
- Desmarestia aculeata (few).
- Dictyosiphon hippuroides (many).
- Ectocarpus fasciculatus (many).
- Laminaria Agardhii (many).

RHODOPHYCEÆ:
- Ahnfeldtia plicata (few).
- Callithamnion Baileyi (many).
- Ceramium rubrum (many).
- Champia parvula (few).
- Chondrus crispus (many).
- Cystoclonium purpurascens (few).
- Cystoclonium purpurascens var. cirrhosum (few).
- Dasya elegans (1).
- Phyllophora Brodiæi (many).
- Polysiphonia elongata (1).
- Polysiphonia nigrescens (few).
- Rhodomela subfusca (1).
- Rhodymenia palmata (1).
- Spyridia filamentosa (few).

FISH HAWK STATION 7730.

August 8, 1905.—(*a*) Prospect Hill-Nashawena, 115° 59′, Nashawena-Gay Head, 87° 59′; (*b*) Prospect Hill-Pasque, 92° 27′, Pasque-Gay Head, 115° 22′; (*c*) Prospect Hill-Pasque, 101° 57′, Pasque-Gay Head, 118° 41′; 12 fathoms; hard sand; 9-foot beam trawl and mud bag.

ANIMALS.

FORAMINIFERA:
- Biloculina ringens.
- Discorbina rosacea.
- Miliolina seminulum.
- Rotalia beccarii.

PORIFERA:
- Cliona celata (much).

HYDROZOA:
- Eudendrium dispar.
- Halecium halecinum.
- Hydractinia echinata.
- ?Obelia geniculata.
- Pennaria tiarella.

BRYOZOA:
- Ætea anguina.
- Bicellaria ciliata.
- Bugula turrita.
- Cellepora americana.
- Hippuraria armata.
- Lichenopora verrucaria.
- Membranipora tenuis.
- Schizoporella unicornis.
- Smittia trispinosa nitida.

ASTEROIDEA:
- Asterias forbesi (1).
- Asterias vulgaris (2).
- Henricia sanguinolenta (1 large).

OPHIUROIDEA:
- Amphipholis squamata.

ECHINOIDEA:
- Echinarachnius parma (2 shells and 1 living).

ANNULATA:
- Diopatra cuprea (1 tube).
- Harmothoë imbricata (1).
- Lepidonotus squamatus.
- Nicolea simplex (3).
- Pseudopotamilla oculifera (many tubes).
- ?Spirorbis spirorbis (few).

COPEPODA:
- Argulus megalops (1).

DECAPODA:
- Cancer irroratus (several).
- Crago septemspinosus (1).
- Homarus americanus (several).
- Libinia emarginata (many small).
- Ovalipes ocellatus (few).
- Pagurus acadianus (several).
- Pagurus annulipes (several).
- Pagurus longicarpus (few).

AMPHIPODA:
- Æginella longicornis (very many large and small).
- Ampelisca macrocephala (1).
- Ampelisca spinipes (3).
- Amphithoë rubricata (1).
- Byblis serrata (4).
- Corophium cylindricum (2).
- Ericthonius minax (4 males, 1 female).
- Ericthonius rubricornis (1 female).
- Pontogenia inermis (10 small).
- Unciola irrorata (2 small).

ISOPODA:
- Edotea montosa (1).
- Erichsonella filiformis (2).
- Idothea phosphorea (several).

PELECYPODA:
- Anomia simplex (many shells).
- Astarte undata (several shells).
- Callocardia morrhuana.
- Cardium pinnulatum (few living and shells).
- Clidiophora gouldiana (1 living and 1 shell).
- Cyclas islandica (1 shell).
- Divaricella quadrisulcata (1 shell).
- Ensis directus (1 shell).
- Lyonsia hyalina (3 shells).
- Modiolaria nigra (few very small living).
- Mytilus edulis (1 living).
- Nucula proxima (1 shell).
- Pecten gibbus borealis (1 fragment and 1 shell).
- Pecten magellanicus (1 fragment).
- Spisula solidissima (several shells).
- Tellina tenera (few living and 1 shell).
- Venericardia borealis (few shells).
- Venus mercenaria (1 large shell).

GASTROPODA:
- Anachis avara (few).
- Astyris lunata.
- Lacuna puteola (2).
- Polynices heros (several).
- Tritia trivittata (few living and shells).
- Vermicularia spirata (1 shell).

CEPHALOPODA:
- Loligo pealii.

TUNICATA:
- Amaroucium stellatum.

PISCES:
- Pseudopleuronectes americanus (3).
- Raja erinacea (3).
- ?Raja ocellata (1).

PLANTS.

PHÆOPHYCEÆ:

Chorda filum (drifted fragments).
Desmarestia aculeata (few).
Desmarestia viridis (few).
Dictyosiphon hippuroides (few).
Fucus vesiculosus (drifted fragment).
Sargassum Filipendula (drifted fragments).

RHODOPHYCEÆ:

Agardhiella tenera (few).
Antithamnion cruciatum (few).
Ceramium tenuissimum (few).
Cystoclonium purpurascens var. cirrhosum (many).
Grinnellia americana (1).
Polysiphonia elongata (few).
Polysiphonia nigrescens (many).

PHALAROPE STATION 52.

August 11, 1904.—7–6½ fathoms; shelly and gravelly.

ANIMALS.

HYDROZOA:

Tubularia crocea (few tubes).

BRYOZOA:

Bugula turrita (many).

ASTEROIDEA:

Asterias forbesi (several).
Asterias vulgaris (several).
Henricia sanguinolenta (2).

ECHINOIDEA:

Arbacia punctulata (few).
Echinarachnius parma (many).
Strongylocentrotus droebachiensis (several living).

ANNULATA:

Diopatra cuprea (many tubes).
Harmothoë imbricata (common).
Hydroides dianthus (few).
Nephthys incisa (1 fragment).
Nereis pelagica (several).
Pista sp. (fragment of 1 tube).
Pseudopotamilla oculifera (1).
Sabellaria vulgaris (1 tube).

DECAPODA:

Cancer irroratus (many small).
Crago septemspinosus.
Libinia emarginata (several small).
Pagurus acadianus (2 small).
Pagurus annulipes (few).
Pagurus longicarpus (many).

AMPHIPODA:

Corophium cylindricum (1).
Ischyrocerus anguipes (1 small).
Unciola irrorata (1).

ISOPODA:

Erichsonella filiformis.

PELECYPODA:

Anomia aculeata (1 shell).
Anomia simplex (few shells).
Arca transversa (few living and shells).

PELECYPODA—Continued.

Astarte castanea (several).
Astarte undata (few).
Callocardia morrhuana (many shells).
Cardium pinnulatum (common, living).
Clidiophora gouldiana (many shells).
Cochlodesma leanum (abundant).
Corbula contracta (1 shell).
Crassinella mactracea (many living).
Crenella glandula.
Cumingia tellinoides (few shells).
Ensis directus (small living).
Lyonsia hyalina (1 living).
Modiolaria nigra (few shells).
Modiolus modiolus (few shells).
Mulinia lateralis (few shells).
Mytilus edulis (few).
Nucula proxima (few).
Pecten magellanicus (1 shell).
Petricola pholadiformis (2 shells).
Spisula solidissima (many shells).
Tellina tenera (few shells).
Venericardia borealis.
Venus mercenaria (few shells).
Yoldia limatula (1 shell).

GASTROPODA:

Anachis avara (several shells).
Astyris lunata (many living).
Busycon canaliculatum (1).
Cæcum cooperi.
Cerithiopsis emersonii (1 shell).
Crepidula convexa (several living).
Crepidula fornicata (many shells).
Crepidula plana (many living).
Lacuna puteola (few shells).
Littorina rudis (1 living, 2 shells).[a]
Polynices duplicata (few, 1 living).
Polynices heros (few shells).
Polynices triseriata (several living and shells).
Tritia trivittata (living and many shells).

[a] The occurrence of this species in the present dredge haul is inexplicable The specimens doubtless came from much nearer shore, being retained in the net, perhaps, from the preceding haul.

GASTROPODA—Continued.
Urosalpinx cinereus (few).
AMPHINEURA:
Chætopleura apiculata (several).
CEPHALOPODA:
Loligo pealii (1 mass of eggs).
PISCES:
Myoxocephalus æneus (few).
Raja sp., egg capsule (1).

PLANTS.

PHÆOPHYCEÆ:
Chordaria flagelliformis (few).
Ralfsia clavata (few).
RHODOPHYCEÆ:
Agardhiella tenera (many).
Antithamnion cruciatum (few).
Corallina officinalis (few).
Cystoclonium purpurascens (few).
Cystoclonium purpurascens var. cirrhosum (few).
Griffithsia Bornetiana (few).
Lithothamnion polymorphum (few).
Phyllophora Brodiæi (few).
Polysiphonia nigrescens (many).
Rhodymenia palmata (few).
Seirospora Griffithsiana (many).
Spyridia filamentosa (many).

PHALAROPE STATION 83.

July 12, 1905.—North shore of Pasque Island; 5–7 fathoms; sand.

ANIMALS.

FORAMINIFERA:
Miliolina circularis.
PORIFERA:
Cliona celata (2 pieces).
HYDROZOA:
Hydractinia echinata.
Sertularia sp.
Thuiaria argentea.
Tubularia crocea (dead tubes).
ACTINOZOA:
Astrangia danæ (several small).
BRYOZOA:
Ætea anguina.
Bugula turrita.
Crisia eburnea (few).
Hippothoa hyalina.
Lepralia sp. (americana or pallasiana).
Membranipora pilosa.
Membranipora tenuis.
Schizoporella unicornis.
Smittia trispinosa nitida.
ASTEROIDEA:
Asterias vulgaris (1 small).
Henricia sanguinolenta (1 small).
ECHINOIDEA:
Arbacia punctulata (spines).
Echinarachnius parma (1 shell).
ANNULATA:
Diopatra cuprea (few tubes).
Harmothoë imbricata (2 very small).
Hydroides dianthus (several).
Lepidonotus squamatus (1).
Nereis arenaceodentata (1).
Nereis pelagica (1 young).
Pista sp. (fragments of several tubes).
Spirorbis sp. (2 tubes).
CIRRIPEDIA:
Balanus sp. (probably eburneus) (few).
SCHIZOPOD:
Schizopod (undetermined).
DECAPODA:
Crago septemspinosus (many).
Homarus americanus (1 fragment).
Libinia emarginata.
Pagurus annulipes (several).
Pagurus longicarpus (common).
AMPHIPODA:
Leptochelia savignyi.
ISOPODA:
?Edotea acuta (1).
INSECTA:
Sarcophaga sp. larva (probably not actually dredged from bottom).
PELECYPODA:
Arca transversa (several).
Astarte castanea (few living).
Callocardia morrhuana (few).
Cardium pinnulatum (several shells).
Clidiophora gouldiana (1 living).
Corbula contracta (few shells).
Crassinella mactracea (several living and shells).
Crenella glandula (2 shells).
Cumingia tellinoides (2 shells).
Ensis directus (shells).
Mytilus edulis (fragments and young).
Ostrea virginica (1 living).
Pecten gibbus borealis (2 shells).
Yoldia limatula (few, 1 living).
AMPHINEURA:
Chætopleura apiculata (2).

GASTROPODA:
- Anachis avara (common, living and shells).
- Astyris lunata.
- Cochlodesma leanum (1 shell).
- Crepidula convexa (1 living).
- Crepidula fornicata (many shells).
- Crepidula plana (few).
- Eupleura caudata (several shells).
- Littorina litorea (1 shell).
- Polynices triseriata (common, living and shells).
- Tritia trivittata (many living).
- Urosalpinx cinereus (few shells).
- Vermicularia spirata (several shells).

TUNICATA:
- Didemnum lutarium (several masses).
- Molgula manhattensis (2).

PISCES:
- Myoxocephalus æneus.

PLANTS.

PHÆOPHYCEÆ:
- Desmarestia aculeata (many).
- Leathesia difformis (1 drift).

RHODOPHYCEÆ:
- Callithamnion roseum (2).
- Corallina officinalis (1 drift).
- Cystoclonium purpurascens var. cirrhosum (many).
- Phyllophora Brodiæi (many).
- Phyllophora membranifolia (many).
- Polyides rotundus (many).
- Polysiphonia nigrescens (many).
- Polysiphonia urceolata (1).
- Rhodomela subfusca (1).

2. THE DISTRIBUTION CHARTS.

We have deemed it advisable to publish a large number of charts portraying the distribution of species as revealed by the station records. It is not likely that the lists of station numbers given in the text for each species will often be translated by the reader into definite localities; while, on the other hand, the generalized statements of the authors are necessarily incomplete and at best do not take the place of graphic representations such as the charts. Some explanation is necessary for a proper understanding of these last. With a few exceptions, they are based upon the records of the regular dredging stations only, i. e., those for the years 1903, 1904, and 1905.[a] No data derived from outside information, however reliable, have been included here, nor even data from our own shore collecting, or (exceptions aside) from our supplementary dredgings and repetitions of earlier stations, though, of course, such additional data have been incorporated in the text. The exceptions mentioned include the "bis" stations as a whole (see p. 55), the records from which have been plotted for all species. In the case of the Foraminifera, hydroids, and Bryozoa, many records derived from supplementary dredgings (repeated stations) during the summers of 1906–1909 have been plotted upon the charts. This has been considered advisable owing to the probable imperfection of the original records for all of these organisms.

Such procedure is open to two objections. In the first place, the repeated stations are at best rather rough approximations to the original ones whose numbers have been given them. Even with the greatest care, it is impossible to lower a dredge at precisely the same point as on a previous occasion, and in the case of most of our repetitions, lack of time prevented the maneuvering necessary to a very exact location of the spot originally charted. In the second place, the repeated stations were not distributed with any regularity throughout the region dredged, and unless due caution is exercised the results of these are likely to be misleading. Moreover, since the records from these have been plotted only for certain groups, undue emphasis has in some cases probably been thrown upon the latter. Despite these objections, however, we believe that the distributions

[a] Including the completion of the western shore of Buzzards Bay in 1907.

of the species in question have been portrayed more fairly, on the whole, than if the supplementary records had been omitted.

Without making certain allowances one might be greatly misled by these charts. Some of the sources of possible misconception have just been referred to. For all groups the greater apparent abundance of various species in Vineyard Sound, as compared with Buzzards Bay, is frequently to be explained merely by the greater number of dredging stations in the former. The *Fish Hawk* was employed during two seasons upon the Vineyard Sound series of stations, while systematic dredging by this vessel in Buzzards Bay was limited to the summer of 1904. Thus there are 218 *Fish Hawk* stations in Vineyard Sound and only 66 in Buzzards Bay, although the latter is a considerably larger body of water. The concentration of stations in the Sound, so obvious upon the chart, is thus explained. The latter condition is emphasized by the inclusion in the distribution charts of records from the "bis" stations (see above), all of which were in Vineyard Sound. This disparity in the thoroughness with which the two bodies of water were worked was due (1) to the fact that the earlier and more or less experimental dredgings were conducted in Vineyard Sound, and it was regarded as desirable to repeat these; and (2) to the greater uniformity of conditions throughout the bottom of Buzzards Bay, rendering it unnecessary to dredge at such frequent intervals.

Another point for which allowance must be made is the fact that the apparent absence of a species from a given area is in some cases due merely to the absence, for the time, of a collector accustomed to search for this particular form, or even to the lack of dredging apparatus suitable for bringing it up. Such cases, and other possible sources of error, will be discussed in their proper places in connection with particular groups of animals.

Finally, reference must be made to certain spurious distribution patterns, which result, not from any defect in our own methods, but from the transportation of organic remains to points where the animals themselves had probably never lived. As an illustration of this phenomenon we may mention the occurrence of shells of the common oyster in the deeper parts of Vineyard Sound, where their presence is probably to be attributed to passing vessels. Another instance is the transportation of littoral shells (e. g., *Littorina litorea*) by hermit crabs, and it is likely that the lighter shells of certain mollusks and the remains of various other organisms are carried to considerable distances by currents.

The distribution charts are reproduced from maps plotted out by Mr. James W. Underwood and Miss Edith Chapman. These assistants employed a blank form based upon a chart prepared by the draftsman of the Bureau, Mr. W. F. Hill. The stars were first put in with a rubber stamp and then filled out with a drawing pen and india ink. Owing to the crowding of stations or the proximity of some of these to shore, the star is, in many cases, at some distance from the station to which it belongs.

It has not been thought worth while to plot the distributions of any species which were taken at less than 10 of the stations. On the other hand, the distributions of all animals,[a] with a few special exceptions, which were listed from 10 or more stations have been presented herewith. Thus the charts are restricted to the more representa-

[a] This statement does not strictly hold for the plants.

tive species comprised in our local benthos. In many cases, however, highly instructive data have been obtained regarding forms of less frequent occurrence. Such have been referred to in the text.

Records entered as doubtful have been excluded in plotting the distribution charts. In the charts for the shell-bearing mollusks and echinoderms, and for the coral *Astrangia*, it will be found that the stars are in many cases surrounded by circles. The circle in each case indicates that one or more *living* specimens were recorded from the station in question; absence of the circle implies either that the records indicate the presence of dead shells only, or that no statement has been made on the subject.

3. THE FAUNA CONSIDERED ACCORDING TO REGIONS AND HABITATS.

Many of the species encountered during our dredging operations were found to have a practically unrestricted distribution within the waters explored. In the case of many other species, their distribution was found to be definitely restricted, i. e., they were adapted to particular temperatures or to particular kinds of bottom. These various types of distribution will be discussed at some length in relation to particular species which serve to illustrate them, and many cases are portrayed graphically by means of charts. But it is likewise important that a list of the more prevalent species should be presented synoptically for each subregion of our chart and for each variety of habitat. With this in view the stations were tabulated in various ways, according to the type of bottom or the like; and for each of these groups lists were prepared comprising all of those species which were taken at one-fourth or more of the stations in question.[a] We believe that lists thus restricted may be regarded as comprising only such species as are truly representative of these various bottoms. It must be conceded, however, that many of the less common forms which do not appear in the lists at all may be highly characteristic of one or another group of stations, and may, indeed, be limited to these.

Preceding the lists for particular waters or particular types of bottom we present a table comprising those species which were taken at one-fourth or more of the total number of dredging stations of the Survey, i. e., at 115 or more of the regular stations.[b] It is believed that such a list conveys a good idea of the prevailing benthic fauna of our local waters, so far as we can speak of any single prevailing fauna where the conditions differ so widely. This list will perhaps render possible the detection of future changes in the relative abundance of certain species.

---

[a] At first only those species were listed which were present at half or more of a given group of stations, but it was found that all of the resulting lists were very brief, and that they omitted many highly characteristic forms.

[b] None of the supplementary stations, except the "bis" stations of 1904, have been considered in the present computations. The inclusion of the 1909 records would doubtless change the complexion of these tables somewhat, though not, we believe, very materially.

I. *Species recorded from one-fourth (115) or more of the regular dredging stations of the Survey.*[a]

PORIFERA:
Cliona celata (171).
ACTINOZOA:
Astrangia danæ (158).
BRYOZOA:
Crisia eburnea (201).
*Bugula turrita (255).
Schizoporella unicornis (197).
Smittia trispinosa nitida (163).
ASTEROIDEA:
Henricia sanguinolenta (118).
Asterias forbesi (206).
ECHINOIDEA:
Arbacia punctulata (156).
Echinarachnius parma (170).
ANNULATA:
Harmothoë imbricata (189).
Lepidonotus squamatus (165)
Nereis pelagica (192).
Diopatra cuprea (198).
*Hydroides dianthus (237).
CIRRIPEDIA:
Balanus eburneus (162).
AMPHIPODA:
Unciola irrorata (115).
DECAPODA:
Crago septemspinosus (169).
*Pagurus longicarpus (290).
Pagurus annulipes (196).
DECAPODA—Continued.
Libinia emarginata (192).
Cancer irroratus (209).
Neopanope texana sayi (143).
PELECYPODA:
*Anomia simplex (256).
Pecten gibbus borealis (162).
Mytilus edulis (217).
Modiolus modiolus (120).
*Arca transversa (264).
Nucula proxima (205).
Crassinella mactracea (182).
Cardium pinnulatum (219).
Callocardia morrhuana (192).
Tellina tenera (193).
*Ensis directus (235).
Spisula solidissima (222).
*Clidiophora gouldiana (234).
Corbula contracta (128).
GASTROPODA:
*Tritia trivittata (373).
*Anachis avara (295).
*Astyris lunata (245).
Urosalpinx cinereus (156).
Littorina litorea—*shells only* (131).
*Crepidula fornicata (326).
*Crepidula plana (291).
Polynices heros (165).
Polynices triseriata (144).

II. *Species which were taken at one-fourth (55) or more of the Fish Hawk stations in Vineyard Sound.*

PORIFERA:
Cliona celata (76).
HYDROZOA:
Eudendrium ramosum (58).
Hydractinia echinata (62).
ACTINOZOA:
Astrangia danæ (70).
BRYOZOA:
Crisia eburnea (97).
Bugula turrita (135).
Schizoporella unicornis (112).
Smittia trispinosa nitida (84).
Cellepora americana (55).
ASTEROIDEA:
Henricia sanguinolenta (62).
Asterias forbesi (119).
Asterias vulgaris (73).
ECHINOIDEA:
Arbacia punctulata (101).
Echinarachnius parma (130).
ANNULATA:
Harmothoë imbricata (90).
Lepidonotus squamatus (86).
Nereis pelagica (115).
Diopatra cuprea (75).
Hydroides dianthus (94).
CIRRIPEDIA:
Balanus eburneus (83).
DECAPODA:
Crago septemspinosus (73).
Pagurus pollicaris (70).
Pagurus longicarpus (131).
Pagurus annulipes (77).
Libinia emarginata (99).
Cancer irroratus (134).

[a] The number in parenthesis indicates the number of stations at which the species was found. Species are starred (in the first list only), which were taken at one-half or more of the stations.

AMPHIPODA:
Unciola irrorata (68).
PELECYPODA:
Anomia simplex (93).
Mytilus edulis (136).
Modiolus modiolus (85).
Arca transversa (116).
Nucula proxima (82).
Venericardia borealis (59).
Astarte castanea (74).
Crassinella mactracea (90).
Cardium pinnulatum (66).
Callocardia morrhuana (62).
Tellina tenera (77).
Ensis directus (94).
Spisula solidissima (140).
PELECYPODA—Continued.
Clidiophora gouldiana (94).
Corbula contracta (64).
GASTROPODA:
Tritia trivittata (163).
Anachis avara (131).
Astyris lunata (116).
Urosalpinx cinereus (63).
Crepidula fornicata (144).
Crepidula plana (136).
Polynices heros (119).
CEPHALOPODA:
Loligo pealii (55).
TUNICATA:
Amaroucium pellucidum (57).

In a considerable measure the above list is a repetition of the first. Only four species comprised in the first list are wanting in the second, while only nine additional ones are to be found in the latter. This close agreement is doubtless due to the fact that the *Fish Hawk* stations in Vineyard Sound are more than three times as numerous as are those in Buzzards Bay. They thus have an undue share in determining the character of the first of our lists.

III. *Species taken at one-fourth (17) or more of the Fish Hawk stations in Buzzards Bay.*

PORIFERA:
Cliona celata (32).
ACTINOZOA:
Astrangia danæ (29).
BRYOZOA:
Crisia eburnea (24).
Ætea anguina (22).
Bugula turrita (35).
Schizoporella unicornis (31).
Smittia trispinosa nitida (25).
ASTEROIDEA:
Asterias forbesi (23).
ANNULATA:
Nephthys incisa (34).
Diopatra cuprea (34).
Ninoë nigripes (31).
Rhynchobolus americanus (22).
Chætopterus pergamentaceus (21).
Spiochætopterus oculatus (28).
Cistenides gouldii (19).
Clymenella torquata (25).
Hydroides dianthus (30).
CIRRIPEDIA:
Balanus eburneus (36).
AMPHIPODA:
Ampelisca macrocephala (17).
Ptilocheirus pinguis (26).
Unciola irrorata (22).
DECAPODA:
Crago septemspinosus (28).
Pagurus longicarpus (52).
Pagurus annulipes (27).
Libinia emarginata (39).
Cancer irroratus (26).
Neopanope texana sayi (31).
PELECYPODA:
Anomia simplex (52).
Pecten gibbus borealis (32).
Mytilus edulis (17).
Arca transversa (50).
Nucula proxima (37).
Yoldia limatula (44).
Crassinella mactracea (21).
Cardium pinnulatum (55).
Lævicardium mortoni (26).
Venus mercenaria (34).
Callocardia morrhuana (56).
Tellina tenera (37).
Macoma tenta (19).
Ensis directus (40).
Mulinia lateralis (45).
Clidiophora gouldiana (52).
GASTROPODA:
Busycon canaliculatum (32).
Tritia trivittata (65).
Anachis avara (37).

GASTROPODA—Continued.
Astyris lunata (18).
Eupleura caudata (40).
Urosalpinx cinereus (18).
Littorina litorea (28).
Crepidula fornicata (55).
GASTROPODA—Continued.
Crepidula plana (46).
Polynices duplicata (21).
Polynices triseriata (30).
CEPHALOPODA:
Loligo pealii (18).

The number of species in the foregoing list (55) is slightly greater than that in the one immediately preceding it (51). It will be shown later that the average number of species per dredge haul was likewise somewhat greater in Buzzards Bay. This is true despite the fact that in the aggregate about 25 per cent more species were taken in Vineyard Sound than in Buzzards Bay. Of the 55 species contained in the foregoing table, 33 (55 per cent) are common to the list for the *Fish Hawk* stations in Vineyard Sound, while 22 are to be regarded as more particularly characteristic of Buzzards Bay. On the other hand, 18 of the more prevalent species in the Sound list do not appear in that for the Bay. Of the 22 characteristic Bay-dwelling species, 7 are annelids and 11 are mollusks; the 18 species peculiar to the Vineyard Sound list are more diversified.

The *Phalarope* and *Blue Wing* stations represent dredgings in the shoaler waters, and are for the most part much closer to land than those of the *Fish Hawk*. The more prevalent species from these stations will therefore be presented in separate lists.

IV. *Species taken at one-fourth (19) or more of the Phalarope and Blue Wing stations in Vineyard Sound.*

PORIFERA:
?Grantia ciliata (21).
Cliona celata (32).
HYDROZOA:
Tubularia crocea (27).
ACTINOZOA:
Astrangia danæ (26).
BRYOZOA:
Crisia eburnea (50).
Bugula turrita (42).
Schizoporella unicornis (29).
Smittia trispinosa nitida (25).
ASTEROIDEA:
Henricia sanguinolenta (36).
Asterias forbesi (24).
ECHINOIDEA:
Echinarachnius parma (31).
ANNULATA:
Harmothoë imbricata (40).
Lepidonotus squamatus (37).
Nereis pelagica (51).
Diopatra cuprea (35).
Hydroides dianthus (47).
AMPHIPODA:
Amphithoë rubricata (26).
Corophium cylindricum (21).
ISOPODA:
Idothea phosphorea (30).
Erichsonella filiformis (25).
DECAPODA:
Crago septemspinosus (27).
Pagurus longicarpus (46).
Pagurus annulipes (44).
Libinia emarginata (29).
Cancer irroratus (33).
Neopanope texana sayi (23).
PELECYPODA:
Anomia simplex (41).
Anomia aculeata (28).
Pecten gibbus borealis (26).
Mytilus edulis (42).
Arca transversa (36).
Nucula proxima (25).
Crassinella mactracea (32).
Cardium pinnulatum (35).
Callocardia morrhuana (20).
Tellina tenera (31).
Ensis directus (33).
Cumingia tellinoides (23).
Spisula solidissima (35).
Clidiophora gouldiana (28).
GASTROPODA:
Tritia trivittata (59).
Anachis avara (63).
Astyris lunata (57).
Urosalpinx cinereus (36).
Littorina litorea (19).

GASTROPODA—Continued.
Lacuna puteola (39).
Crepidula fornicata (55).
Crepidula plana (50).
Polynices heros (27).
Polynices triseriata (35).

TUNICATA:
Amaroucium pellucidum (25).
Amaroucium pellucidum constellatum (23).
Didemnum lutarium (24).

PISCES:
Myoxocephalus æneus (22).

The number of species here comprised is very close to those in the two lists immediately preceding it. Of the 54 species here present, 38 (70 per cent) were contained in the list for the *Fish Hawk* stations of Vineyard Sound, 16 being wanting from the latter. Conversely, the *Fish Hawk* list contained 13 species which do not appear in that for the *Phalarope*. It does not follow, by any means, that a species which is limited to one or the other of these lists is actually restricted as to depth or proximity to shore. Indeed, most of them appear with considerable frequency in the dredgings of both vessels. Of the 16 species which are confined to the *Phalarope* list, only 3 show a marked restriction to the vicinity of the shore line. These are *Amphithoë rubricata*, *Lacuna puteola*, and *Littorina litorea*. The last named, as is well known, is strictly littoral (i. e., intertidal) in its habitat. The dredging records refer exclusively to shells, most or all of which were doubtless transported from the shore by hermit crabs. On the other hand, of the 13 species restricted to the *Fish Hawk* list, only 6 give any evidence of a preference for deeper waters than those dredged by the *Phalarope* and *Blue Wing*. These are *Eudendrium ramosum*, *Cellepora americana*, *Asterias vulgaris*, *Modiolus modiolus*, *Venericardia borealis*, and *Astarte castanea*. In the case of the last two species named, the avoidance of the inshore waters is quite obvious. Of the others this can not be stated as confidently.

V. *Species taken at one-fourth (23) or more of the Phalarope stations in Buzzards Bay.*

PORIFERA:
Cliona celata (31).

HYDROZOA:
Hydractinia echinata (33).

ACTINOZOA:
Astrangia danæ (33).

BRYOZOA:
Crisia eburnea (30).
Bugula turrita (45).
Schizoporella unicornis (25).
Smittia trispinosa nitida (29).

ASTEROIDEA:
Asterias forbesi (39).

ECHINOIDEA:
Arbacia punctulata (29).

ANNULATA:
Harmothoë imbricata (40).
Lepidonotus squamatus (28).
Diopatra cuprea (53).
Pista palmata (25).
Clymenella torquata (24).
Hydroides dianthus (66).

CIRRIPEDIA:
Balanus eburneus (27).

DECAPODA:
Crago septemspinosus (41).
Pagurus longicarpus (59).
Pagurus annulipes (48).
Libinia emarginata (25).
Neopanope texana sayi (37).

PELECYPODA:
Anomia simplex (68).
Pecten gibbus borealis (61).
Arca transversa (62).
Nucula proxima (61).
Yoldia limatula (26).
Crassinella mactacea (39).
Cardium pinnulatum (62).
Lævicardium mortoni (60).
Venus mercenaria (41).
Callocardia morrhuana (54).
Tellina tenera (48).
Ensis directus (68).
Cumingia tellinoides (38).
Spisula solidissima (28).
Mulinia lateralis (30).
Lyonsia hyalina (31).
Clidiophora gouldiana (59).
Corbula contracta (36).

AMPHINEURA:
Chætopleura apiculata (23).
GASTROPODA:
Busycon canaliculatum (24).
Tritia trivittata (85).
Anachis avara (64).
Astyris lunata (54).
Eupleura caudata (37).
Urosalpinx cinereus (39).
GASTROPODA—Continued.
Bittium alternatum (37).
Littorina litorea (54).
Crepidula fornicata (72).
Crepidula convexa (32).
Crepidula plana (58).
Polynices duplicata (36).
Polynices triseriata (30).
TUNICATA:
Didemnum lutarium (27).

The total number of species in the foregoing list (54) is exactly the same as that contained in the one immediately preceding it. In fact there has been a rather striking uniformity in the numbers comprised in these lists, ranging as they do from 46 to 55. Of the 54 species in the foregoing table, 41 (76 per cent) are common to this and to the list of *Fish Hawk* species in Buzzards Bay. On the other hand, a number not much inferior to this (37 = 69 per cent[a]) are common to the present list and to that given for the *Phalarope* stations of Vineyard Sound, among the latter being some which are not recorded in the other Buzzards Bay list. A few others in this list are only found elsewhere in the *Fish Hawk* list for Vineyard Sound.

While, therefore, the *Phalarope* list for Buzzards Bay resembles the *Fish Hawk* list for Buzzards Bay more closely than any of the others, it must be pointed out that it contains a considerable number of species which are prevalent throughout the Sound, but which in the Bay are to be found only at the inshore dredging stations. This fact, which is not very strikingly illustrated by these figures, will appear much more clearly when the charts portraying the distribution patterns of certain species are scrutinized.

Tables have likewise been prepared listing the "prevalent" species for each type of bottom. The same criterion has here been employed of admitting only those species which have been encountered at one-fourth or more of the number of stations belonging to the group in question.

After considerable thought the following classification of bottoms has been adopted for present purposes, not as being an ideal one, but as being the most simple one possible consistent with a fair regard for accuracy. The only strictly exact classification would recognize as many types of bottom as there are combinations of ingredients listed; but such a classification would be altogether too cumbersome for the purposes of our statistical treatment. We realize that the grouping here employed must result in a quite inadequate characterization of the habitat of many species. A specimen may ostensibly have come from a muddy or a sandy bottom, when, in reality, it was growing attached to a shell or other solid object. We have, nevertheless, included as muddy and sandy those bottoms in which shells were likewise recorded. This has been done for the reason that shells or fragments of these were scarcely ever wholly lacking from the contents of the dredge. Again, certain living mollusks which move freely over the bottom afford support for attached organisms just as well as do dead shells. Surely the presence of such should not suffice to constitute a "shelly" bottom. The same may be said regarding shells occupied by hermit crabs, which abound throughout the entire region, giving support to hydroids, Bryozoa, barnacles, Crepidulæ of several species, and other organisms.

[a] Only 55 per cent of the *Fish Hawk* list for Buzzards Bay were common to the *Fish Hawk* list for Vineyard Sound.

We have accordingly adopted the following classification of bottoms in the ensuing discussion of habitats:

A. "Sand," including bottoms recorded as pure sand, or sand and shells. Bottoms containing stones, gravel, or mud are excluded.

B. "Gravel and stones," including records which list either of these ingredients singly or in combination with one another or with sand. No bottoms containing mud are here included.

C. "Mud," including bottoms recorded as of mud, muddy sand, or sandy mud. Bottoms are here included in which shells are listed, but not those containing gravel or stones.

Certain combinations (e. g., gravel and mud) are excluded from this classification, and records from such stations are not included in the present list. Such cases are, however, relatively very few.

VI. *Species taken at one-fourth (43) or more of the stations dredged on sandy bottoms.*

PORIFERA:
- Cliona celata (49).

HYDROZOA:
- Hydractinia echinata (46).

BRYOZOA:
- Crisia eburnea (74).
- Bugula turrita (107).
- Schizoporella unicornis (63).
- Smittia trispinosa nitida (44).

ASTEROIDEA:
- Asterias forbesi (71).
- Asterias vulgaris (56).

ECHINOIDEA:
- Arbacia punctulata (48).
- Echinarachnius parma (101).

ANNULATA:
- Harmothoë imbricata (72).
- Lepidonotus squamatus (54).
- Nereis pelagica (72).
- Diopatra cuprea (72).
- Hydroides dianthus (61).

CIRRIPEDIA:
- Balanus eburneus (51).

DECAPODA:
- Crago septemspinosus (80).
- Pagurus longicarpus (101).
- Pagurus annulipes (59).
- Libinia emarginata (62).

DECAPODA—Continued.
- Cancer irroratus (92).
- Ovalipes ocellatus (43).

PELECYPODA:
- Anomia simplex (97).
- Pecten gibbus borealis (52).
- Mytilus edulis (113).
- Arca transversa (105).
- Nucula proxima (62).
- Venericardia borealis (49).
- Astarte undata (44).
- Astarte castanea (59).
- Crassinella mactracea (72).
- Cardium pinnulatum (83).
- Callocardia morrhuana (78).
- Tellina tenera (96).
- Ensis directus (84).
- Spisula solidissima (109).
- Clidiophora gouldiana (88).
- Corbula contracta (46).

GASTROPODA:
- Tritia trivittata (142).
- Anachis avara (95).
- Astyris lunata (94).
- Urosalpinx cinereus (46).
- Crepidula fornicata (124).
- Crepidula plana (111).
- Polynices heros (80).
- Polynices triseriata (51).

Of the foregoing 46 species all but 2 appear in one or both of the lists for Vineyard Sound. On the other hand, 8 of the species do not appear in either list for Buzzards Bay, and 14 do not appear in the *Fish Hawk* list for Buzzards Bay. These facts follow directly, of course, from the well-known differences of these two bodies of water in respect to the character of their bottoms.

VII. *Species taken at one-fourth (42) or more of the stations for which bottoms of gravel or stones were recorded.*

PORIFERA:
Cliona celata (91).
HYDROZOA:
Eudendrium ramosum (43).
Hydractinia echinata (43).
Tubularia crocea (44).
Thuiaria argentea (47).
ACTINOZOA:
Astrangia danæ (98).
BRYOZOA:
Crisia eburnea (97).
Ætea anguina (50).
Bugula turrita (99).
Schizoporella unicornis (96).
Smittia trispinosa nitida (90).
ASTEROIDEA:
Henricia sanguinolenta (82).
Asterias forbesi (83).
ECHINOIDEA:
Arbacia punctulata (80).
ANNULATA:
Harmothoë imbricata (80).
Lepidonotus squamatus (87).
Nereis pelagica (93).
Diopatra cuprea (70).
Pseudopotamilla oculifera (42).
Hydroides dianthus (118).
CIRRIPEDIA:
Balanus eburneus (63).
AMPHIPODA:
Unciola irrorata (46).
DECAPODA:
Pagurus pollicaris (47).
Pagurus longicarpus (106).
DECAPODA—Continued.
Pagurus annulipes (93).
Libinia emarginata (69).
Cancer irroratus (71).
Neopanope texana sayi (64).
PELECYPODA:
Anomia simplex (83).
Pecten gibbus borealis (51).
Mytilus edulis (74).
Modiolus modiolus (69).
Arca transversa (81).
Nucula proxima (69).
Crassinella mactracea (78).
Cardium pinnulatum (55).
Ensis directus (86).
Cumingia tellinoides (59).
Spisula solidissima (84).
Clidiophora gouldiana (66).
Corbula contracta (55).
AMPHINEURA:
Chætopleura apiculata (55).
GASTROPODA:
Tritia trivittata (117).
Anachis avara (127).
Astyris lunata (103).
Urosalpinx cinereus (79).
Littorina litorea (42).
Crepidula fornicata (113).
Crepidula plana (103).
Polynices heros (59).
Polynices triseriata (48).
TUNICATA:
Amaroucium pellucidum (49).
Amaroucium pellucidum constellatum (61).
Didemnum lutarium (70).

Of the 54 species in the foregoing list, only 4 are lacking from one or both lists for Vineyard Sound, while 11 are not to be found in either list for Buzzards Bay. Thirty-seven of the species (69 per cent) are common to the list for sandy bottoms.

VIII. *Species taken at one-fourth (28) or more of the stations dredged on muddy bottoms.*

PORIFERA:
Cliona celata (31).
ACTINOZOA:
Astrangia danæ (28).
BRYOZOA:
Crisia eburnea (30).
Bugula turrita (49).
Schizoporella unicornis (35).
Smittia trispinosa nitida (29).
ASTEROIDEA:
Asterias forbesi (48).
ANNULATA:
Harmothoë imbricata (35).
Nephthys incisa (43).
Diopatra cuprea (54).
Ninoë nigripes (35).
Cistenides gouldii (32).
Clymenella torquata (36).
Hydroides dianthus (55).

CIRRIPEDIA:
Balanus eburneus (46).
AMPHIPODA:
Ptilocheirus pinguis (41).
Unciola irrorata (32).
DECAPODA:
Crago septemspinosus (50).
Pagurus longicarpus (83).
Pagurus annulipes (44).
Libinia emarginata (57).
Cancer irroratus (43).
Neopanope texana sayi (43).
PELECYPODA:
Anomia simplex (74).
Pecten gibbus borealis (57).
Arca transversa (78).
Nucula proxima (74).
Yoldia limatula (66).
Crassinella mactracea (29).
Cardium pinnulatum (79).
Lævicardium mortoni (45).
PELECYPODA—Continued.
Venus mercenaria (52).
Callocardia morrhuana (80).
Tellina tenera (63).
Macoma tenta (30).
Ensis directus (64).
Spisula solidissima (29).
Mulinia lateralis (60).
Clidiophora gouldiana (80).
GASTROPODA:
Busycon canaliculatum (43).
Tritia trivittata (108).
Anachis avara (67).
Astyris lunata (48).
Eupleura caudata (48).
Urosalpinx cinereus (29).
Littorina litorea, shells only (48).
Crepidula fornicata (84).
Crepidula plana (74).
Polynices duplicata (35).
Polynices triseriata (41).

Of the 50 species comprised in the above list only two[a] are absent from that representing the prevailing species dredged by the *Fish Hawk* in Buzzards Bay; while only 7 species in the latter list are lacking from that for the muddy bottoms. The two groups of species are thus not far from identical. On the other hand, 13 of those in the list for muddy bottoms do not appear in either table for Vineyard Sound. Thirty-three of the species (66 per cent) are common to the list for sandy bottoms, while 34 species (68 per cent) are common to that for bottoms of gravel and stones.

Comparing the lists for the three types of bottom, we find 13 species which appear only in that for bottoms of stones and gravel, an equal number which appear only in the list for muddy bottoms, while 6 are peculiar to the list for sandy bottoms. Of the 13 prevalent mud-dwelling forms, all but 1 are annelids or mollusks. Of the 13 species peculiar to the list for gravelly and stony bottoms, 3 are hydroids and 3 are ascidians, the remainder being distributed through various phyla. The number of forms which are restricted to our list of prevalent species for bottoms of pure sand (free from mud on the one hand, and from stones and gravel on the other) is a very short one. This is due to the fact that the great majority of sand-dwelling species are not deterred by the presence of a certain proportion of stones and gravel, while many of them are equally at home in sand which is somewhat muddy. In our classification, however, such bottoms have been included under "gravel and stones" and "mud," respectively. At least two of the species listed are, nevertheless, pretty definitely restricted to bottoms of pure sand. These are the "lady crab" (*Ovalipes ocellatus*) and the "sand dollar" (*Echinarachnius parma*).

In any consideration of such tables as the foregoing, it must be borne in mind that the fact of a species being restricted to one or another of the tables does not imply that it is absent from the other types of bottom, or subdivisions of the region. Indeed, it

[a] These two are contained in the *Phalarope* Buzzards Bay list.

sometimes happens that the species is recorded from an *absolutely greater* number of stations of another group than that for which it is here listed. Again, the caution must be repeated (cf. p. 31, 33) that in the field a specimen was frequently recorded from a certain type of bottom when it seems probable that the dredge, at the moment of taking it, was passing over a quite different type of bottom. In many parts of our local sea floor several distinct varieties of bottom may be encountered within a quite limited area.

Nevertheless, we believe that real and important facts of ecology are revealed by such tabulations as the foregoing, even though these may not in themselves present a complete picture. For concrete illustrations of the assemblage of organisms which may actually occur together on a given bottom, or at least within the area traversed during a single dredge haul, the reader is referred to the tables on pages 58 to 62.

Thus far the lists of "prevailing" species for one or another group of stations have had no reference to the temperature factor. It has been thought desirable, however, to present a list of those species which have been taken at one-fourth or more of the stations within the cold-water area of the region, i. e., the area throughout which the water temperature in summer has been found to be considerably lower than elsewhere. For this purpose the *Fish Hawk* stations (and these only) were chosen, lying, in Vineyard Sound, beyond (southwest of) a line drawn from Robinsons Hole to Kopeecon Point, and in Buzzards Bay below a line drawn from Barneys Joy Point to Penikese Island. One hundred and one stations were included in this area.

IX. *Species taken at one-fourth (25) or more of the stations in the colder waters adjacent to the open ocean.*

HYDROZOA:
- Hydractinia echinata (34).
- *Obelia geniculata* (27).
- *Halecium halecinum* (27).

BRYOZOA:
- Crisia eburnea (43).
- Ætea anguina (25).
- Bugula turrita (70).
- Schizoporella unicornis (46).
- Cellepora americana (30).

ASTEROIDEA:
- Asterias forbesi (51).
- Asterias vulgaris (58).

ECHINOIDEA:
- Arbacia punctulata (25).
- Echinarachnius parma (70).

ANNULATA:
- Harmothoë imbricata (39).
- Nereis pelagica (35).
- Diopatra cuprea (43).

CIRRIPEDIA:
- Balanus eburneus (37).

AMPHIPODA:
- Unciola irrorata (27).
- *Æginella longicornis* (35).

ISOPODA:
- Idothea phosphorea (26).

DECAPODA:
- Crago septemspinosus (49).
- *Pagurus acadianus* (39).
- Pagurus longicarpus (59).
- Libinia emarginata (37).
- Cancer irroratus (75).
- *Ovalipes ocellatus* (41).

PELECYPODA:
- Anomia simplex (54).
- *Pecten magellanicus* (26).
- Mytilus edulis (82).
- Modiolus modiolus (25).
- Arca transversa (60).
- Nucula proxima (30).
- Venericardia borealis (63).
- *Astarte undata* (51).
- Astarte castanea (44).
- Crassinella mactracea (41).
- Cardium pinnulatum (55).
- Callocardia morrhuana (63).
- Tellina tenera (55).
- Ensis directus (30).
- Spisula solidissima (72).

PELECYPODA—Continued.
Clidiophora gouldiana (58).
Corbula contracta (33).
GASTROPODA:
Tritia trivittata (88).
Anachis avara (40).
Astyris lunata (48).
Crepidula fornicata (65).
Crepidula plana (62).
GASTROPODA—Continued.
Polynices heros (60).
Polynices triseriata (35).
CEPHALOPODA:
Loligo pealii (37).
PISCES:
Raja erinacea (31).
Lophopsetta maculata (31).

In the foregoing table it will be noted that only nine species (those italicized) have not already appeared in one or more of the lists for Vineyard Sound or Buzzards Bay. And not all these nine are species whose distribution has been determined by temperature; for example, *Ovalipes*, *Raja*, and *Lophopsetta* (see below). Such a list is thus ill adapted to displaying the peculiarities of the fauna occupying the colder waters of the region. But an examination of the distribution charts reveals the presence of a considerable number of species which are chiefly or wholly restricted to the colder waters under consideration. A list of these has been given below, along with the recorded range of each upon the North American coast. It will be seen that in 15 out of 20 cases the range of these species is predominantly northward,[a] some of them, indeed, being near their southern limit of distribution. The presence of three of the others (*Ovalipes ocellatus*, *Molgula arenata*, and *Lophopsetta maculata*) is sufficiently explained by the nature of the bottom at the western end of the Sound, since these are characteristic sand-dwelling species.[b]

X. *Species restricted to, or at least occurring predominantly in, the colder waters of Vineyard Sound and Buzzards Bay.* (Limited to species occurring at 10 or more stations.)

CŒLENTERATA:
Eudendrium dispar.—Vineyard Sound to Bay of Fundy. (N.)
Alcyonium carneum.—Rhode Island to Gulf of St. Lawrence. (N.)
ECHINODERMATA:
Asterias vulgaris.—Labrador to Cape Hatteras, but not littoral south of Woods Hole. (N.)
Strongylocentrotus droebachiensis.—Circumpolar, south to New Jersey. (N.)
CRUSTACEA:
Calliopius lævіusculus.—Narragansett Bay to Greenland. (N.)
Pontogenia inermis.—Vineyard Sound to Arctic Ocean. (N.)
Pagurus acadianus.—Grand Bank to mouth of Chesapeake Bay. (N.)
Ovalipes ocellatus.—Cape Cod to Gulf of Mexico. (S.)
MOLLUSCA:
Pecten magellanicus.—Labrador to Cape Hatteras. (N.)
Modiolaria nigra.—Arctic seas to Cape Hatteras. (N.)
Crenella glandula.—Arctic seas to Cape Hatteras. (N.)
Venericardia borealis.—Arctic seas to off Cape Hatteras. (N.)
Astarte undata.—Gulf of St. Lawrence to Cape Hatteras. (N. and S.)
Cyclas islandica.—Arctic Ocean to Cape Hatteras [in deep water]. (N.)
Thracia conradi.—Labrador to Cape Hatteras. (N.)
Buccinum undatum.—Arctic seas to Charleston Harbor. (N.)
Crucibulum striatum.—Nova Scotia to Florida Keys. (S.)

a See p. 184 for standard employed in grouping species as "northward ranging" or "southward ranging."

b *Ovalipes* and *Lophopsetta*, indeed, are known to occur on sand flats at various points throughout the region, irrespective of temperature.

TUNICATA:
Molgula arenata.—New Haven to Nantucket. (?)
Eugyra glutinans. (N.)
PISCES:
Lophopsetta maculata.—Casco Bay to South Carolina. (S.)

Passing reference should likewise be made to certain species which were taken at less than 10 stations, and which, therefore, are not included among those charted. Some of these species are *Polymastia robusta* (a sponge), *Tealia crassicornis* (an anemone), *Ophiopholis aculeata* (an ophiuroid), *Thyone unisemita* (a holothurian), *Pandalus leptocerus* (a shrimp), and *Hyas coarctatus* (a crab). Each of these has been recorded more than once at the open ends of the Bay and the Sound, but never, so far as we know, in the more inclosed waters.

For the sake of comparison with the foregoing, a list is presented herewith comprising those species which were taken at two or more of the seven regular Survey stations at Crab Ledge, off Chatham. Here, as stated above (p. 51), the bottom temperature of the water in summer is considerably lower than at the western end of Vineyard Sound, and many degrees lower than in the greater part of the area dredged by us.

XI.—*Species dredged at 2 or more of the 7 Survey stations at Crab Ledge.*

FORAMINIFERA:
Discorbina rosacea (3).
PORIFERA:
Polymastia robusta (5).
Halichondria panicea (5).
Desmacidon palmata (6).
HYDROZOA:
Eudendrium ramosum (2).
Hydractinia echinata (7).
Tubularia tenella (3).
Tubularia crocea (6).
Sertularella tricuspidata (3).
ACTINOZOA:
Metridium dianthus (5).
Alcyonium carneum (3).
BRYOZOA:
(Not listed for these stations individually.)
ASTEROIDEA:
Henricia sanguinolenta (5).
Asterias austera (6).
Asterias vulgaris (7).
OPHIUROIDEA:
Ophiopholis aculeata (6).
ECHINOIDEA:
Strongylocentrotus droebachiensis (7).
ANNULATA:
Harmothoë imbricata (3).
Nereis pelagica (5).
Nothria conchylegia (2).
Thelepus cincinnatus (6).
Pseudopotamilla oculifera (4).
Chætinopoma greenlandica (2).
Filograna implexa (5).
AMPHIPODA:
Ericthonius rubricornis (2).
DECAPODA:
Pagurus acadianus (6).
Pagurus kroyeri (4).
Hyas coarctatus (5).
Cancer irroratus (3).
PELECYPODA:
Anomia simplex (2).
Anomia aculeata (4).
Pecten magellanicus (4).
Mytilus edulis (2).
Modiolus modiolus (6).
Modiolaria lævigata (5).
Venericardia borealis (3).
Astarte undata (3).
Cyclas islandica (2).
Spisula solidissima (4).
Thracia septentrionalis (2).
Saxicava arctica (4).
Cyrtodaria siliqua (3).
GASTROPODA:
Coryphella salmonacea (3).
Buccinum undatum (6).
Chrysodomus decemcostatus (2).
Tritonofusus stimpsoni (3).
Boreoscala grœnlandica (5).
Polynices triseriata (2).
Velutina zonata (2).
TUNICATA:
Halocynthia echinata (2).
Amaroucium stellatum (3).
Didemnum lutarium (6).

Among the foregoing species, the following have been already mentioned as restricted, in Vineyard Sound and Buzzards Bay, chiefly or wholly to the colder waters adjoining the open ocean: *Polymastia robusta, Alcyonium carneum, Asterias vulgaris, Ophiopholis aculeata, Strongylocentrotus droebachiensis, Pagurus acadianus, Hyas coarctatus, Pecten magellanicus, Venericardia borealis, Astarte undata, Cyclas islandica, Buccinum undatum.* In reality the number of those species which are common to Crab Ledge and the colder parts of Vineyard Sound and Buzzards Bay, but which are not encountered elsewhere in local waters, is considerably greater than this brief list would imply.

A contrary condition is found in the case of certain species which are of general distribution throughout Vineyard Sound, and in many cases throughout Buzzards Bay as well, but which are nearly or quite absent from just those waters to which the foregoing species seem best adapted. The following is a partial list of such, based upon an examination of the distribution charts.

XII. *Species which appear to be scarce or lacking in the colder waters of Vineyard Sound and Buzzards Bay.* (Limited to species which occur at 10 or more stations of the Survey.)

COELENTERATA:
Astrangia danæ.—Florida to Cape Cod. (S.)
Thuiaria argentea.—North Polar regions to Maryland. (N.)
ECHINODERMATA:
Arbacia punctulata.—Nantucket Shoals to Yucatan. (S.)
ANNULATA:
Lumbrineris hebes.—Casco Bay to New Jersey. (N. and S.)
Hydroides dianthus.—Massachusetts Bay to Charleston, South Carolina. (S.)
CRUSTACEA:
Batea secunda.—Local. (?)
Pagurus annulipes.—Nantucket Sound to Florida. (S.)
Pelia mutica.—Vineyard Sound to Florida. (S.)
Neopanope texana sayi.—Cape Cod to Florida. (S.)
PYCNOGONIDA:
Anoplodactylus lentus.—Long Island Sound, Vineyard Sound, Eastport, 1 record. (?)
Tanystylum orbiculare.—Marthas Vineyard to Virginia. (S.)
MOLLUSCA:
Vermicularia spirata.—New England to West Indies. (S).
Chætopleura apiculata.—Cape Cod to West Indies. (S).
TUNICATA:
Perophora viridis.—Woods Hole to Beaufort, N. C., and Bermuda. (S.)
Styela partita.—Massachusetts Bay to North Carolina. (S.)
Amaroucium stellatum.—Cape Cod to North Carolina.? (S.)
Amaroucium pellucidum.—Vineyard Sound to North Carolina. (S.)

It will be noted that only one of these species has a predominantly northern range upon our coast. It is also to be pointed out that, with a single exception (*Amaroucium stellatum*), none of these species have been recorded by us from Crab Ledge.[a] We do not wish to lay undue emphasis upon such correspondences, however. It is likely that some of these species actually occur at Crab Ledge, in spite of our failure to find them. It is likewise probable for some of them, at least, that their distribution in

[a] I. e., not *once*. We do not here refer to the above table of species taken two or more times.

Vineyard Sound is not determined by temperature, but by the character of the bottom. Nevertheless, after making these allowances, the significance of the facts discussed upon the last few pages can scarcely be doubted.

4. THE AVERAGE YIELD OF THE DREDGE HAULS.

Another method of portraying synoptically the general facies of our local fauna, as revealed by the dredge, is to present the average composition of the dredge hauls. This we have computed for the Survey as a whole, and for the separate groups of stations which have been distinguished above; for the animal kingdom as a whole, and for its main subdivisions. In the following tables certain groups which were represented very sparingly in our dredgings, or which were not looked for systematically, and certain others which do not properly belong to the benthos have been omitted.

I. *Average number of genera and species of animals taken per dredge haul.*

	Genera.	Species.
Survey as a whole (458 stations)	34.3	37.0
Fish Hawk, Vineyard Sound (218 stations)	33.7	36.5
Fish Hawk, Buzzards Bay (66 stations)	36.3	38.7
Fish Hawk, Crab Ledge (7 stations)	37.0	39.7
Phalarope and Blue Wing, Vineyard Sound (77 stations)	32.1	35.2
Phalarope, Buzzards Bay (90 stations)	36.0	38.5

While there is a rather surprising uniformity amongst these figures, it will be noted that the average number of species is slightly greater for the *Fish Hawk* than for the *Phalarope* stations; likewise that it is greater for Buzzards Bay than for Vineyard Sound, and greatest of all for Crab Ledge. It is of interest, likewise, that the average number of genera per dredge haul is nearly equal to that of the species. This point will be discussed later.

II. *Average number of genera and species for the 458 regular stations of the Survey, showing representation of each group of animals.*

Group.	Genera.	Species.	Group.	Genera.	Species.
Porifera	.7	.7	Cirripedia	.4	.4
Hydrozoa	1.4	1.4	Decapoda	2.8	3.5
Actinozoa	.4	.4	Amphipoda	1.6	1.6
Nemertinea	.04	.05	Isopoda	.4	.4
Bryozoa	2.8	2.9	Pycnogonida	.1	.1
Asteroidea	.8	1.0	Pelecypoda	8.9	9.2
Ophiuroidea	.1	.1	Amphineura	.2	.2
Echinoidea	.8	.8	Gastropoda	5.9	6.8
Holothuroidea	.03	.03	Cephalopoda	.2	.2
Annulata	4.3	4.3	Tunicata	.9	1.1
Sipunculida	.05	.05	Pisces	1.1	1.1

In the foregoing table, it is nearly certain that the figures for certain groups, especially, perhaps, for the Porifera, do not fairly represent the number of these forms. For this reason, indeed, the Foraminifera have been omitted altogether. As stated in another section (p. 91), the Foraminifera were looked for systematically during one season only, while the Porifera at no time received adequate attention.

III. *Average number of species per dredge haul for the two vessels and the two bodies of water considered separately.*

Group.	Fish Hawk stations.			Phalarope and Blue Wing stations.	
	Vineyard Sound (218).	Buzzards Bay (66).	Crab Ledge (7).	Vineyard Sound (77).	Buzzards Bay (90).
Porifera	0.6	0.8	2.3	0.9	0.7
Hydrozoa	2.0	.7	3.9	1.1	.8
Actinozoa	.5	.5	1.1	.4	.4
Nemertinea	.01	.2	.....	.01	.02
Bryozoa	3.4	2.7	(a)	3.0	2.0
Asteroidea	1.2	.6	3.0	1.0	.6
Ophiuroidea	.1	.1	.9	.1	.07
Echinoidea	1.2	.2	1.0	.6	.4
Holothuoridea	.01	.09	.....	.04	.01
Annulata	3.5	6.2	5.9	4.6	4.6
Sipunculida	.01	.02	.....	.01	.2
Cirripedia	.4	.5	.3	.2	.3
Amphipoda	1.8	1.3	.7	1.9	1.1
Isopoda	.3	.09	.....	.8	.3
Decapoda	3.8	3.4	3.3	3.2	3.2
Pycnogonida	.2	.02	.....	.1	.....
Pelecypoda	8.2	11.5	7.4	7.5	11.6
Amphineura	.2	.2	.....	.2	.3
Gastropoda	5.4	7.4	4.7	7.2	9.7
Cephalopoda	.3	.3	.....	.06	.....
Tunicata	1.3	.4	3.3	1.6	.7
Pisces	1.5	1.3	.4	.6	.3

a The Crab Ledge Bryozoa have not been listed by stations.

In a similar way we have represented the wealth in species of each of the types of bottom which have been distinguished (see p. 70).

IV. *Average number of genera and species per dredge haul for the three types of bottom.*

	Genera.	Species.
Sand (170)	33.6	36.5
Gravel and stones (167)	35.3	38.0
Mud (112)	34.8	37.2

While there is here, likewise, a rather surprising uniformity among the figures, it is to be noted that the number of species is greatest for the stony bottoms and least for the sandy ones.

V. *Average number of species per dredge haul, showing the representation of the various groups of animals on each type of bottom.*

Group.	Sand.	Gravel and stones.	Mud.
Porifera	0.5	1.0	0.5
Hydrozoa	1.5	1.8	.8
Actinozoa	.3	.7	.3
Nemertinea	.02	.01	.1
Bryozoa	2.8	3.7	2.0
Asteroidea	.9	1.3	.6
Ophiuroidea	.08	.1	.2
Echinoidea	1.0	.8	.4
Holothuroidea	.02	.01	.05
Annulata	3.4	4.7	5.2
Sipunculida	.05	.03	.1
Cirripedia	.3	.4	.4
Amphipoda	1.6	1.6	1.6
Isopoda	.5	.4	.2
Decapoda	3.5	3.5	3.6
Pycnogonida	.05	.2	.03
Pelecypoda	9.8	7.7	11.0
Amphineura	.1	.3	.1
Gastropoda	6.5	6.7	7.8
Tunicata	.9	1.9	.4
Pisces	1.4	.7	1.2

To what degree such figures as the foregoing, giving the average number of species per dredge haul, represent the actual wealth in species of the various subdivisions of our local sea bottom can not be stated with certainty. Whether, for example, the greater number of species per dredge haul found in Buzzards Bay denotes an actually greater number of species per unit area of sea floor, is not self-evident. It is plain that the dredge must cut more deeply into a bottom of soft mud than into one of hard sand or gravel, and that therefore a larger proportion of burrowing organisms will be obtained in the former. It seems quite possible, therefore, that the excess in favor of Buzzards Bay has been exaggerated, or that it does not exist at all.

Now, an inspection of table VI, showing the total number of species taken at each of the five groups of stations, reveals the fact that the number of species taken by the *Fish Hawk* in Vineyard Sound is about 25 per cent greater than that taken in Buzzards Bay. But it must likewise be borne in mind that the number of *Fish Hawk* stations in Vineyard Sound was over three times as great as that in Buzzards Bay, thus rendering probable the capture of a larger number of the less common species. In fact, it will be noticed that the figures expressing the total number of species for each of these groups of stations may be arranged in the same order as those expressing the number of stations in each group.[a] We nevertheless think it likely, in view of all our data, that the actual number of species inhabiting Vineyard Sound is greater than that inhabiting Buzzards Bay. This is probably due to the fact that the bottom of the former

[a] That the number of species in each case is in no sense proportional to the number of stations is, however, quite plain.

presents a greater diversity of conditions than that of the latter, rendering it a fit habitation for a greater variety of life. Such a view is in no way inconsistent with the supposition that the number of species *per unit area* is as great, or even greater, in Buzzards Bay. This matter will be referred to later.

VI. NUMBER OF SPECIES TAKEN ONE OR MORE TIMES DURING THE DREDGING.[a]

Group.	Vineyard Sound.			Buzzards Bay.			Crab ledge.
	Fish Hawk.	Phalarope.	Total.	Fish Hawk.	Phalarope.	Total.	
Foraminifera	17	1	18	.....	19	19	1
Porifera	9	8	10	5	7	9	3
Hydrozoa	14	12	16	7	9	9	11
Actinozoa	4	3	4	2	1	2	2
Nemertinea	2	.....	2	4	2	6	.....
Bryozoa	29	26	32	13	18	21	(b)
Asteroidea	3	3	3	3	3	3	6
Ophiuroidea	2	1	2	2	2	3	1
Echinoidea	3	3	3	3	3	3	1
Holothuroidea	2	1	2	2	1	2	.....
Annulata	51	41	60	38	38	48	17
Sipunculida	1	1	2	1	2	3	.....
Ostracoda	20	.....	20	.....	5	5	.....
Cirripedia	2	1	2	1	1	1	2
Amphipoda	25	23	29	11	18	20	5
Isopoda	6	6	8	2	9	9	.....
Cumacea	1	1	2	.....	.....	.....	.....
Schizopoda	1(+?)	1(+?)	1(+?)	.....	1(+?)	1(+?)	1
Decapoda	20	13	21	11	15	17	9
Pycnogonida	2	3	3	1	.....	1	.....
Xiphosura	1	.....	1	1	1	1	.....
Pelecypoda	49	36	49	38	40	43	23
Amphineura	1	1	1	1	2	2	.....
Gastropoda	38	34	48	30	42	47	13
Cephalopoda	1	.....	1	1	.....	1	.....
Tunicata	16	11	17	4	8	9	8
Pisces	25	13	27	13	8	15	3
Total	345	243	384	194	255	300	[b] 100

[a] This table relates to the "regular" stations only. Species of uncertain identity have been included along with the determined ones in these computations.

[b] Bryozoa not included.

5. EXPLANATION OF THE FAUNAL CATALOGUE.

Part III of the present work consists of a catalogue or annotated list of the fauna of the Woods Hole region. The extent of territory comprised within the limits of the "Woods Hole Region," as here conceived, has already been indicated in chapter I, of the present volume, where we have likewise discussed the sources of information upon which the present catalogue is based.

It is true that an insignificant proportion, numerically considered, of those who frequent the laboratories at Woods Hole at the present time are interested primarily in systematic zoology or botany. But every working biologist, whatever his specialty,

deals with one or more species of animals or plants, which constitute, or at least furnish him with, the raw materials for his research. Thus, it is of advantage to all that a carefully prepared list of these organisms should be published, if regarded merely as a catalogue of available material. And it will, we trust, be of additional advantage to have at hand a single reference work which shall embody the nomenclature most recently adopted for these species by some of our most competent systematic experts. Confusion will, we think, be minimized by the existence of some standard, even though this standard may be a fallible one.

In the present catalogue we are offering, however, far more than a mere list of species. We have gathered together all available data regarding distribution within local waters, seasonal occurrence, reproduction, etc., and have added various ecological notes, where these have seemed appropriate. It is our hope that these data may be of service to those who are in search of material for embryological or other studies. And we further hope that the decidedly meager notes which we offer may constitute a nucleus for future growth in this direction.

It must be emphasized that we do not in any sense guarantee the trustworthiness of all the records herein contained. A large proportion of them have been included wholly upon the authority of others, whose names are mentioned in the text. Many species are included, indeed, which have never been seen either by the present writers or by the specialists who have collaborated with us. While such citations are, in most cases, based upon the statements of recognized authorities, it is more than possible that in some cases they rest upon errors of observation or of identification. But it would have been a very difficult task to cull out such mistakes, and we have therefore included all records based upon the statements of persons believed to be trustworthy, unless we happen to have definite evidence that these statements were erroneous. The mere failure of subsequent observers to find a species which had been included in one of the earlier lists is not to be regarded as decisive evidence of an error, in view of the known instances of change in the population of our local waters.

Due credit has been given in a large proportion of cases to the authority for each statement made, the name of this person being inserted at the close of the citation. The person cited is responsible only for so much of the statement as immediately precedes his name. Independent citations are in nearly all cases separated by periods. In many instances the statement cited has never been published by the individual referred to, but has been communicated to one of the present authors orally or recorded in manuscript. Where no authority has been indicated for a given statement we mean either (1) that the present authors are themselves responsible for the observation, or (2) that the fact stated is a matter of common knowledge to a large number of observers, or (3), in certain self-evident cases, that the bibliographic reference indicates the authority for the statement.

With most groups of animals, as already stated, a certain proportion of the specimens collected were referred to specialists for identification. Since the value of a record depends, in great measure, upon the trustworthiness of the identification, we have indicated in a large number of cases, the authority for the latter. The symbols (* and the like) denote that specimens from the localities so designated have been identified by persons mentioned in a foot note at the commencement of the list. In the case of those organisms specimens of which were invariably referred to specialists, symbols

have been omitted in connection with the records, the general acknowledgments in chapter IV being regarded as sufficient. In other cases, failure to mention the authority for a determination implies that the specimen was identified by one of the present authors. This is true of the great majority of readily recognizable species belonging to various phyla.

It must be borne in mind that the number of specimens recorded for a given station represents, in many cases, the number saved and listed, rather than the number actually brought in by the dredge. For many animals, especially minute ones, the former figure may give no adequate idea of the relative abundance of the species in a given dredge haul.

The bibliographic references under each species will be found to be very limited in number, and to include, with a few exceptions, only those works which mention the occurrence of this species within the limits of the region here under consideration. One work has been regularly included, however, even in cases where no mention was made of Woods Hole or vicinity by the authors. This is the "Report upon the Invertebrate Animals of Vineyard Sound" by Verrill and Smith (1873). Likewise, in the list of mollusks, we have regularly included page references to Binney's edition of Gould's "Report on the Invertebrata of Massachusetts," and for the fishes references to Jordan and Evermann's "Fishes of North and Middle America." It has not been thought worth while to cite the first description of each species nor even to refer to any description or figure. To have included these would doubtless have added considerably to the usefulness of this report, but we need only remind the reader that the search for such few bibliographic citations as are here offered required many months of thoroughly uninspiring labor. In many cases reference to original descriptions and figures may be found in one or another of the works here cited. Bibliographic lists, limited almost wholly to the works referred to in connection with the separate species, have been appended to the zoological and botanical sections of the catalogue.

In order to facilitate the finding of a species which has been listed by a name unfamiliar to the reader, a certain number of synonyms have been included in connection with the bibliographic references. Only those names are included, however, by which the species in question has been designated in the various works relating to our local fauna. The synonyms here listed are all included in the systematic index. This will probably render possible the finding of a desired species in a large proportion of cases.

As respects classification and nomenclature, we have found it expedient, and indeed unavoidable, to follow within each group some one authority, this authority being, in most cases, the same person who has been responsible for the identification of our species. Only thus has it been possible to avoid a quite interminable examination of the literature on our part. This precedure has frequently led to our being obliged to substitute quite unfamiliar names for ones long current among American biologists, and to our listing under separate genera species which, to everyone but the taxonomist, are scarcely distinguishable from one another as species. No one could deplore more than we do the necessity for such changes, and this regret is the keener because of the confidence we feel that many of these names are not the ones that will ultimately stand.

Several years' experience in the preparation of our faunal catalogue has brought home to us in a forcible way some of the most exasperating of the evils relating to

zoological nomenclature. Indeed, it is upon the authors of works like this, who make extensive use of taxonomic names, while having very little share in their creation or transmutation, that these evils perhaps fall most heavily.

On the other hand, we realize that there are many sides to this perplexing question, and that many of the generic and specific names in current use among Woods Hole biologists are entirely unjustified, as judged by any standard except local usage. Those who revolt because the long-cherished name of a favorite species has been replaced by a totally unfamiliar one, must be reminded that this is not always due to the caprice of some perverse "species monger." Nor are these changes in all cases due to the discovery that some long-forgotten name has "priority." There are several other (legitimate) reasons for changing the name of a species, of which mention may be made of two. (1) Careful comparison may reveal the fact that two supposedly distinct species dwelling in different parts of the world are, in reality, identical. One or the other name must be given up. Thus, we have over and over again been obliged to abandon names given by earlier American zoologists to species found upon the shores of the New World. We need only mention the "*Spongia sulphurea*" of Desor (=*Cliona celata* Grant), the "*Hydractinia polyclina*" of Agassiz (now believed to be identical with *H. echinata* Fleming), or the "*Ascidia tenella*" of Stimpson (=*Ciona intestinalis* (Linnæus)). In such cases, the changes may at first jar upon our nerves, but they must be accepted. (2) More complete knowledge of a species may show that its systematic position has at first been misunderstood. Here, as in the first case, we are not dealing with rules of nomenclature, but with facts. If the facts demand it, the species must be assigned to another genus. The most severe critics of our systematic brethren would hardly doubt the wisdom of removing the toadfish from the genus *Gadus*, to which it had been assigned by Linnæus; nor the expediency of so restricting the genus *Nautilus* as to exclude the spiral Foraminifera!

Many cases are sure to arise, however, when the mere *user* of zoological names—and to this class belong the great majority of present day zoologists—may well query whether the more refined grouping of species could not better be carried out within the limits of the genus itself. The latter procedure has the advantage of leaving the generic name (and therefore the full name of the species) unaltered. It is not so much for the changing of their conceptions of relationship that systematic zoologists are criticised so sharply as for their persistent changing of the names which we are all obliged to use and which we must learn anew as often as substitutes are offered by accredited authorities. This criticism derives particular force from the fact that there is no general agreement as to how inclusive a division the genus shall be. It is safe to say that at the present time the "genera" of some groups of the animal kingdom are as inclusive as the "families" of certain others, while the "genera" of these latter may correspond more nearly to the "subgenera" of the first.

It will be understood without further explanation why we have not adopted the practice, current among certain systematists, of including the subgeneric name, in parenthesis, as an integral part of the name of a species. The subgenus is of interest only to the systematist, who may readily find it by reference to the appropriate systematic treatise. The name of the species is complete without it, and the biologist at large should not be burdened by having to learn trinomials of this sort.

6. SYNOPSIS OF THE FAUNAL CATALOGUE.

A table has been prepared showing the total number of families, genera, and species comprised in our annotated list, grouped according to the larger divisions of the animal kingdom; likewise the number which have been recorded during our dredging operations and the number of those encountered which had not previously been listed for local waters. In this table species have been entered as doubtful, either because the determination of the species was made with doubt, or because of uncertainty whether the specimens taken really came from within the region here considered.[a]

In the "undetermined" column are included species which have been referred to a genus but not to a species, provided only that no determined member of the same genus has also been listed with which the species in question may be identical.

Species have been listed as "taken by dredge" which were recorded either from the regular dredging stations of the survey or from any of our supplementary stations, numbered or unnumbered.

Species have been listed as "added to fauna of region" when it is believed that their local occurrence was recorded for the first time, either as a result of the survey dredging or of the other collecting operations which were carried on during these same years by members of the laboratory staff or by investigators who have cooperated in the work. In many cases, it is true, these additions to our local fauna have been announced in other publications, but their inclusion here seems none the less justifiable.

SYNOPTIC TABLE OF SPECIES COMPRISED IN ANNOTATED LIST.

Groups of organisms.	Number of families represented.	Number of genera.	Number of species (total).		Species taken by dredge.	Species added to fauna of region.
			Determined.	Undetermined.		
Protozoa	(?)	75	99	5	23	28
Porifera	8	15	12(+2?)	5	11(+3?)	3(+1?)
Hydrozoa	34	76(+3?)	132(+8?)	.....	28(+1?)	6(+2?)
Scyphozoa	4(+1?)	5(+1?)	5(+1?)	.....	.....	.....
Actinozoa	9(+2?)	10(+3?)	14(+3?)	.....	4(+2?)	2
Ctenophora	7	7	8	.....	.....	.....
Turbellaria [b]	19	31	40(+1?)	.....	.....	.....
Trematoda	(?)	15	52(+2?)	2	.....	.....
Cestoda	(?)	29	71	3	.....	.....
Nemertinea	9	13	25(+1?)	.....	6	.....
Nemathelminthes	(?)	12	33(+5?)	.....	.....	.....
Chætognatha	1	1	1	1	.....	.....
Dinophilea	1	1	3	.....	.....	.....
Bryozoa	21	36(+1?)	76(+5?)	.....	67(+1?)	44(+1?)
Asteroidea	3	3	6	.....	6	.....
Ophiuroidea	4	6	6	.....	5	.....
Echinoidea	3	4	4	.....	3	.....
Holothuroidea	3	5	8(+1?)	.....	4	.....
Polychæta	35	98	133(+6?)	4	78(+4?)	7(+6?)
Oligochæta	4	8	11	.....	.....	.....
Hirudinea	1	3	4	.....	1	.....
Sipunculida	1	2	3	.....	3	.....

[a] Certain species only recorded from beyond the 20-fathom line, and thus perhaps somewhat extralimital, are also here listed.
[b] The species added by von Graff (1911) have been included in this table. Von Graff's families are likewise included in the computation.

SYNOPTIC TABLE OF SPECIES COMPRISED IN ANNOTATED LIST—Continued.

Groups of organisms.	Number of families represented.	Number of genera.	Number of species (total).		Species taken by dredge.	Species added to fauna of region.
			Determined.	Undetermined.		
Phyllopoda	1(+1?)	2(+1?)	2(+1?)	.....	.....	2
Ostracoda	3	11	26	.....	21	26
Copepoda (free)	13(+1?)	22(+1?)	25(+1?)	.....	.....	14
Copepoda (parasitic)	8	32	58(+2?)	.....	.....	.....
Cirripedia	4	6	15(+2?)	.....	2(+1?)	2
Amphipoda	22(+2?)	54(+5?)	71(+3?)	3	35	9
Isopoda	11(+1?)	20(+2?)	25(+3?)	.....	10	1
Cumacea	3	6	8(+2?)	.....	1	1
Stomatopoda	1	2	3	.....	.....	.....
Schizopoda	2	4	5	.....	1(+?)	1(+?)
Decapoda	20	37(+2?)	51(+4?)	.....	27(+2?)	4
Xiphosura	1	1	1	.....	1	.....
Pycnogonida	5(+1?)	5(+1?)	5(+1?)	.....	4	2
Arachnida	1	1	1	.....	.....	.....
Insecta	(?)	25	16	13	.....	?
Pelecypoda	31	48(+1?)	70(+6?)	.....	57	6
Amphineura	1	2	2	.....	2	.....
Gastropoda	43	81	129(+9?)	1	65(+2?)	17(+?)
Cephalopoda	3	4	4	.....	1	.....
Enteropneusta	1	1	1	.....	.....	.....
Tunicata	10	18	22(+5?)	5	14(+6?)	3(+5?)
Pisces	99	188(+2?)	247(+5?)	1	30	6(+1?)
Reptilia	4	5	5	.....	.....	.....
Aves	12	44	75	.....	.....	.....
Mammalia	6	11(+2?)	12(+3?)	.....	.....	.....
Total	472(+?)	1,085(+25?)	1,625(+82?)	43	510(+22?)	184(+?)

7. COMPARISON OF THE WOODS HOLE CATALOGUE WITH CERTAIN OTHERS.

While it is no part of our present plan to enter into a historical discussion of the progress which has been made in cataloguing the marine fauna and flora of other parts of the world, it has seemed worth while to compare our own annotated list with certain others, both American and European. Accordingly, we have presented in parallel columns the number of species belonging to each group which have been listed for Vineyard Sound and adjacent waters by Verrill and Smith (1873); for eastern Canada by Whiteaves (1901); for the vicinity of Plymouth, England, by the Marine Biological Association (1904); for the Irish Sea by Herdman and his colleagues (1896); and for the Gulf of Trieste by Graeffe (1880–1903).

The work of A. E. Verrill and S. I. Smith, which appeared in the first report of the United States Commissioner of Fish and Fisheries, was the most ambitious attempt which had yet been made to catalogue the fauna of any section of our coast. While nominally a "Report upon the Invertebrate Fauna of Vineyard Sound and the Adjacent Waters," and based primarily upon the earliest dredging operations of the United States Fish Commission, the scope of this work extended to the whole southern shore of New England, and incidentally to more distant points. The report is divided into two chief

sections, the first of which comprises a discussion of the fauna, according to particular habitats and types of bottom (e. g., "rocky shores of the bays and sounds," "muddy bottoms off the open coast," etc.), the second being constituted by the catalogue or annotated list, together with a considerable number of descriptions and figures. The former section contains an extensive mine of ecological facts of interest and value, and despite the somewhat loose and desultory method of treatment the work will remain a classic in American marine ecology. In all, over 650 species were listed by these authors, a considerable number of these being described as new to science. The range of each species, so far as known, was stated, along with its bathymetric distribution and other facts in its natural history.

In preparing our own catalogue of the fauna, we have incorporated all the species recorded from the "Report upon the Invertebrate Animals of Vineyard Sound," excepting such as are plainly extralimital, or such as are believed to have been wrongly identified. A detailed comparison of the two lists furnishes some evidence of a certain amount of change in the composition of our fauna during the past 40 years. Examples of such changes will be discussed in their proper place.

Since the publication of the report of Verrill and Smith no work has appeared upon American marine ecology of a magnitude at all comparable with it. Annotated lists of species have been published, which have amended and extended the records of that report; but these, for the most part, have been restricted to single divisions of the animal kingdom and have given the bare data of distribution, with but slight comment. Probably the most comprehensive of these recent annotated lists dealing with the marine fauna of any portion of the Atlantic coast of the American continent is Whiteaves's "Catalogue of the Marine Invertebrata of Eastern Canada." This work lists more than a thousand species of invertebrate animals, and is said to consist "of a systematic list of all the species from the eastern Canadian seaboard that have been so far identified or described, with notes on their geographical distribution and bathymetrical range."

In order to compare the fauna of these two sections of the American coast, belonging to two recognized zoogeographical "regions," we have indicated in our table the number of species belonging to each major group, which are common to the Woods Hole and the Canadian lists. These figures are probably, in some cases, too low, owing to our failure to recognize the same species under two different names.

Ever since the days of Edward Forbes the exploration of English waters by means of the dredge has been actively prosecuted, and the fauna of various sections of the coast has been catalogued. In recent years the two principal centers for English faunistic studies have been Plymouth and Liverpool. Commencing with the foundation of the Plymouth laboratory in 1887, the waters of that region have been diligently explored, and from time to time lists have been published comprising the entire known fauna and flora or particular groups of organisms.[a] The last of these inclusive lists was published in 1904 and embraced all previous records, so far as they were believed to be authentic.[b] Over 1,200 species of invertebrate animals are catalogued in this report, which includes copious notes upon local distribution, reproduction, and general ecology.

---

[a] These may be found in the Journal of the Marine Biological Association, from 1887 to the present time.

[b] Even this list has been supplemented to some extent.

In its scope this Plymouth census covers an area which "roughly speaking, ... may be said to lie within a radius of 15 miles from the laboratory," and "extends from the shore to a depth of 30 to 35 fathoms." The area is thus somewhat smaller than is comprised within the Woods Hole region,[a] as we have defined it, though considerably greater depths have been included. But the scope of the two catalogues is fairly comparable, save for the exclusion of vertebrates from the Plymouth list, and some instructive comparisons are possible. In the Plymouth region, as in our own, systematic dredging has been carried on throughout considerable areas. Indeed the biological survey conducted by E. J. Allen[b] and his colleagues in adjacent portions of the English Channel appears to be one of the most exhaustive investigations extant of the relations between fauna and bottom deposits.

Commencing with 1885, another group of English biologists, under the lead of Prof. W. A. Herdman, have been engaged in a systematic study of the fauna of the Irish Sea.[c] Especial attention has been devoted to Liverpool Bay and to the vicinity of the Isle of Man, but a large part of the bottom of the Irish Sea has been explored, and the fauna and bottom deposits have been analyzed with great thoroughness. The results of this work have been communicated from time to time in the Reports of the Liverpool Marine Biology Committee, in the Transactions of the Liverpool Marine Biological Society, in the Reports of the British Association, as well as in a separate series of volumes entitled "Fauna of Liverpool Bay" (no. I–V). A complete list of the species recorded up to that date was published in the report of the British Association for 1896, and a synopsis of this list has been included in our comparative table.

The greater number, at least, of the leading biological stations of the world have devoted more or less attention to the enumeration of the organisms found in their immediate vicinity. This is preeminently true of the Naples station, the pioneer among marine laboratories. One need allude only to the splendid monographs comprised in the "Fauna und Flora" series, and to the less pretentious faunistic contributions published from time to time in the "Mittheilungen" of the station. So far as we know, however, no single inclusive list of species has been published which renders possible, without great labor, a comparison with the fauna of Woods Hole.

At the Trieste station, maintained by the Austrian Government on the Adriatic Sea, a census of the local marine fauna has for many years past been conducted by Graeffe (1880–1903), and lists of species have appeared comprising most of the chief divisions of the animal kingdom. Here, as at Plymouth, abundant data are recorded respecting reproduction and general ecology. In the last column of our comparative table we have indicated the number of species recorded by Graeffe for each group of animals.

It is obvious that these various faunal catalogues differ widely from one another in respect to their scope. Three of them are restricted to the invertebrates, while in only one (that of Woods Hole) are the marine birds listed. Likewise, at Woods Hole alone, among these stations, has any serious attempt been made to list the fish parasites, either the worms or the copepods. On the other hand, the Foraminifera and some other groups have received relatively little attention in our survey.

[a] In reality, however, the vast majority of our records relate to a region of much smaller extent.

[b] See Allen (1899), p. 365–542.

[c] Prof. Herdman had some years earlier taken part in a census of the invertebrate fauna of the Firth of Forth. (See Leslie and Herdman, 1881.)

Again, the areas comprised differ widely in their extent, ranging as they do from restricted bodies of water, such as the Gulf of Trieste, to such extensive tracts of ocean as the Irish Sea or the seas bordering the eastern coast of Canada. Even the report of Verrill and Smith, despite its title, covered a much wider territory than that dealt with in the present work, and included greater depths of sea. Indeed, with the exception of the waters of the Gulf of Trieste, those of the Woods Hole region, as here understood, are the most restricted among those considered in respect to bathymetric range.

It would not be fair, therefore, to look to the parallel columns of this table for any really accurate comparison of the faunas of the several regions referred to, either in respect to their wealth or their composition. Especial reservation must be made in accepting the figures representing the number of species common to Woods Hole and to Canada or Plymouth. It is likely that the number of common species has been underestimated, partly owing to the difficulty, without exhaustive research, of resolving the synonymy of the various species; partly to the probable identity, not yet recognized, of various European and American forms. If due caution be exercised, however, we believe that facts of real value may be brought out by the comparison.

Species are here listed as doubtful which are either undetermined or of doubtful identity, provided that they are believed to be distinct from any others included in the same list. Varieties are omitted, except in those cases where the species is represented only by one of its varieties.

SYNOPSIS OF WOODS HOLE MARINE FAUNA, AS COMPARED WITH THAT OF CERTAIN OTHER REGIONS FOR WHICH LISTS HAVE BEEN PREPARED.

Groups of organisms.	Woods Hole (present report).	Verrill and Smith.	Canada (Whiteaves).		Plymouth.		Irish Sea (Herdman).	Trieste (Graeffe).
			Number of species.	Common to Woods Hole.	Number of species.	Common to Woods Hole.		
Protozoa [a]	99(+5?)	.....	64	13	109	19	239	.....
Porifera	12(+7?)	8(+9?)	36(+2?)	6	18	4(+1?)	58	45
Hydrozoa	132(+8?)	60(+1?)	66	41	121	34(+6?)	129(+1?)	64(+2?)
Scyphozoa	5(+1?)	5(+2?)	5	2	8	(2?)	6	9
Actinozoa	14(+3?)	12	44	4	34	2(+1?)	24	29
Ctenophora	8	4(+1?)	4	4	3	2	4	5
Turbellaria	40(+1?)	9	4	2	62(+2?)	2 (+?)	27	.....
Trematoda	52(+4?)	.....	.....	.....	.....	.....	.....	.....
Cestoda	71(+3?)	.....	.....	.....	.....	.....	.....	.....
Nemertinea	25(+1?)	13(+5?)	20(+1?)	7	35	5	24(+2?)	.....
Nemathelminthes	33(+5?)	2	.....	.....	.....	.....	.....	.....
Chætognatha	1(+1?)	1(+1?)	.....	.....	1	.....	1	2
Dinophilea	3	.....	.....	.....	1	.....	1	.....
Bryozoa	76(+5?)	29(+4?)	115	45(+2?)	103(+1?)	28(+4?)	136	56
Brachiopoda	.....	.....	4	.....	.....	.....	2	.....
Phoronis	.....	.....	.....	.....	1	.....	.....	1
Asteroidea	6	5	29	5	9	1	12	10
Ophiuroidea	6	5	21	3	10	(1?)	7	8
Echinoidea	4	4	3	2	8	.....	7	5
Holothuroidea	8(+1?)	6(+1?)	15	4	8	1	8	13
Crinoidea	.....	.....	3	.....	1	.....	1	1
Polychæta [b]	133(+10?)	88(+13?)	105(+1?)	29	148	10	87(+1?)	135

[a] Of 98 Woods Hole Protozoa, only 29 are Foraminifera, while all of those in the other columns belong to the latter group.
[b] Including Polygordiidæ.

SYNOPSIS OF WOODS HOLE MARINE FAUNA, AS COMPARED WITH THAT OF CERTAIN OTHER REGIONS FOR WHICH LISTS HAVE BEEN PREPARED.—Continued.

Groups of organisms.	Woods Hole (present report).	Verrill and Smith.	Canada (Whiteaves).		Plymouth.		Irish Sea (Herdman).	Trieste (Graeffe).
			Number of species.	Common to Woods Hole.	Number of species.	Common to Woods Hole.		
Oligochæta	11	4	.....	.....	3	1	2	2
Myzostomida	.....	.....	.....	.....	1	.....	(1?)	2
Hirudinea	4	5(+1?)	.....	.....	1	.....	1	3
Gephyrea [a]	3	2(+1?)	5(+1?)	1	3	1	1(+1?)	5
Phyllopoda	2(+1?)	1	.....	.....	3	2	2	4
Ostracoda	26	.....	29(+9?)	10	6	.....	57(+1?)	9
Copepoda (free)	25(+1?)	1(?)	1(+1?)	.....	24	5	195	56
Copepoda (parasitic)	58(+2?)	19(+5?)	2(+1?)	.....	1	.....		109(+1?)
Cirripedia	15(+2?)	13	10	6	10	4	10	15
Phyllocarida	.....	.....	1	.....	1	.....	1	1
Amphipoda	71(+6?)	31(+12?)	70(+4?)	20	52	7(+1?)	129	49(+1?)
Isopoda [b]	25(+3?)	21	26	12	30	5	24	51
Cumacea	8(+2?)	5	11	4(+1?)	6	1	17	9
Stomatopoda	3	1	.....	.....	1	.....	.....	2
Schizopoda	5	3(+1?)	7	3	24	1	16	11
Decapoda	51(+4?)	36	34	12	71	3	61	73
Xiphosura	1	1	.....	.....	.....	.....	.....	.....
Pycnogonida	5(+1?)	1(+1?)	11	1(+1?)	8	2(+1?)	12	.....
Arachnida	1	2	.....	.....	.....	.....	.....	.....
Insecta	16(+13?)	20(+5?)	.....	.....	.....	.....	.....	.....
Pelecypoda	70(+6?)	84	100	55	86	5	108(+3?)	107
Amphineura	2	2	8	1	6	.....	10	5
Gastropoda [c]	129(+10?)	97(+1?)	160	63	164	15	207(+3?)	285
Scaphopoda	.....	.....	5	.....	1	.....	3	2
Cephalopoda	4	5	13	.....	11	.....	7	9
Enteropneusta	1	1	.....	.....	.....	.....	.....	1
Tunicata	22(+10?)	20(+5?)	27(+1?)	10	36	2	45(+14?)	75
Cephalochorda	.....	.....	.....	.....	.....	.....	1	.....
Pisces	247(+6?)	.....	.....	.....	.....	.....	134	181
Reptilia	5	.....	.....	.....	.....	.....	.....	.....
Aves	75	.....	.....	.....	.....	.....	.....	.....
Mammalia	12(+3?)	.....	.....	.....	.....	.....	12	.....
Total	1,625(+125?)	626(+69?)	1,058(+21?)	365(+4?)	1,229(+3?)	162(+17?)	1,828(+27?)	1,449(+4?)
Invertebrates (including tunicates)	1,286(+116?)	626(+69?)	1,058(+21?)	.....	1,229(+3?)	.....	1,681(+27?)	1,268(+4?)
Vertebrates	339(+9?)	.....	.....	.....	.....	.....	147	181

[a] Comprising both the "Gephyrea armata" and the Sipunculoidea.
[b] Some of the species comprised in the Trieste list are not marine.
[c] Seventy of the Plymouth gastropods are nudibranchs.

Before leaving this hasty comparison between our own biological census and a few of the similar undertakings elsewhere, reference should be made to certain works in which some features of our own survey are closely paralleled. We must mention first of all the explorations in the Kattegat of the Danish steamer *Hauchs*, under the charge of C. G. J. Petersen. The resemblance between the Danish project and our own lies in the successful endeavor to correlate the distribution of various species with peculiarities of bottom and of water temperature, and particularly in the presentation of a number

of charts portraying the actual distribution patterns of certain species. Unfortunately Petersen thought fit to plot upon each of these charts the records for a considerable number of species (26 in one case), thus rendering it very difficult to distinguish the distribution of any one of these, and to a large extent impairing the usefulness of the charts. Petersen's "General results" (of which an English translation is provided) includes one of the most philosophical discussions which have appeared of the factors determining the distribution of marine animals.

The important paper of E. J. Allen (1899) has already been mentioned in an earlier chapter. Allen has, among other things, presented 16 charts, each portraying the distribution of several species, usually members of the same zoological class. Each species is indicated by a letter, its relative abundance at various points being denoted by the style of type. These distributions are plotted upon an identical form, having the bottom characters indicated by conventional shading. Only scattered patches are thus represented, however, and in general the charts have little in common with our own.

The detailed distribution of numerous marine species has likewise been ascertained by Herdman and his associates for the neighborhood of the Port Erin biological station on the Isle of Man. Seven distribution charts have been published (Herdman, 1901), each chart embracing one or more entire groups of organisms. Upon these charts each species is designated by a number, so that the total distribution of any given form may be ascertained (though rather laboriously) by finding all the various positions occupied by the number which has been assigned to it.